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STATISTICS FOR EFFICIENCY IN SUPERVISION
Of
Telephone Central Office Installation

By

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A Thesis

(Submitted in connection with the requirements for the M.B.A. Degree)

Boston University
College of Business Administration
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PREFACE

The use of statistics has been developed to such a degree in recent years that its very magnitude alone would provide a topic for lengthy discussion. It has taken such strides in the past quarter of a century that it has become a distinct subject of study in institutions of higher instruction. Beyond the confines of these educational circles its development has been even more marked. Statistics has proved itself to be a very valuable tool in government, civic, commercial, religious and financial activities.

It is not the purpose of the author to present the subject of statistics as Statistics alone, but rather to show its value as a tool for controlling and supervising efficiently a particular phase of industry. This thesis, therefore, seeks to present an argument for the use of statistics in business to disclose flagrant miscarriages and pitfalls to the executive whose time is valuable. To take the time and space here to cover the subject of statistics as we find it today, would be just so much lost effort, in view of the many commendable books and articles to be found in the libraries throughout the world. The reader will no doubt appreciate my standpoint when I present

only enough of the elements of statistical presentation to acquaint the student and layman with the subject, so that he will understand the methods and terminology when applied to the specific studies used in this thesis.

As the particular line of industry used for the studies is the construction of telephone central offices, a brief but sufficient treatise will be presented on this subject to likewise acquaint the reader with the nature of the performances on which the statistics are made. This, too, will have to be brief because of the limitless ends to which it could be carried if one attempted to make it entirely exhaustive.

It is probably well at the start to inform the reader that all tables and charts, used in connection with this thesis, are not to be considered authentic as far as the primary information is concerned, but are used only as illustrations to depict the methods commonly used or possible to use in portraying the statistical data. In fact, figures have been actually changed and "doctored", in some cases, in order not to disclose conditions of no concern to

iii

us. For purposes of illustration some faulty conditions and evidence of poor performances will be mythically present to serve our end in demonstrating the value of these studies.

P.C.D.

April 1, 1930

TABLE OF CONTENTS

List of Illustrations

PART ONE

Chapter I

	<u>Page</u>
Introduction	1
1. The Need for Intelligent Analyses	2
Early Uses of Statistics	
Statistics In Modern Business	
2. Production Control	4
The Old Intuitive Method	
Fact-finding and Research	
3. Brief History of Statistics	5
Its Birth and Growth in Various Countries	
Australia, Austria, Belgium, Canada, Denmark,	
France, Germany, Great Britain, Hungary,	
India, Netherlands, Norway, Russia, Sweden	
and United States	

Chapter II

Classification and Description of Data	9
1. Prevailing Methods of Presentation	11
2. Mistakes Common to Graphical Presentation	12
3. Misuses of Statistical Data	13

PART TWO

Chapter III

The Telephone Central Office	14
1. Its Place in the Industry	18
2. Its Capacity	19
3. Its Evolution	20

Contents - 2

Chapter IV

	<u>Page</u>
Types of Central Offices	23
1. The Necessarily Different Types of Exchanges	23
The Magneto Type Office	
The Common Battery Office	
The Machine Switching Office	
2. Material Differences in Types	27
Costs of Construction	
Intervals of Construction	

PART THREE

Chapter V

Research In Production	34
1. Modern Methods of Determining Controls	35
Statistics on Performance	
Statistics on Personnel	
Statistics, the "Searchlight"	

Chapter VI

Organization Studies	39
1. The Payroll	39
Trend of Payroll Dollars	
Trend of Payroll Sub-Divisions	
Comparative Payrolls and Average Earnings	
Overtime	
2. Man-Load	47
Distribution of Man-Load	
Residential Classification of Man-Load	
Resident Labor Distribution	
Advantages of Locally Resident Labor	
3. Personnel	61
A "Birds-eye" View of the Total Personnel	
Educational Classifications	
Age and Service Distribution	
Salary Distribution	
The Individual Man's Progress	

Contents - 3

Chapter VII

	<u>Page</u>
Cost Studies	74
1. Total Operating Cost	74
Trend and Analysis of Operating Cost	
Labor, Overhead and Voucher Costs	
Control of Operating Costs	
2. Specific Costs	80
Relation of Comparative Costs	
Costs of Particular Projects	
3. Labor Costs	82
Construction, Removals and Maintenance	
Maintenance Portion of Labor Costs	
Analysis of Paid Time	
Lost Time Analysis	
Geographical Distribution of Labor Costs	
Marginal Utility of Labor Dollars	
Overtime	
Custom Work	
4. Material	100
Value of Material Installed per Man-Week	
Proportions of Material to Total Cost of Projects	
Comparative Costs of Installing Given Equipment	

Chapter VIII

Other Contributing Factors to Cost	108
1. General Overhead	108
2. Local Administration	110
3. Voucher Expense	111
Emergency Outside Labor	
Emergency Material	
Cartage Charges	
Miscellaneous Small Supplies	
Travel	
Meals	
Board and Lodging	
Motor Vehicle Maintenance	

Contents - 4

Chapter IX

	<u>Page</u>
Schedule Studies	117
1. Total Current Projects	117
Ratio of Large and Small Jobs	
Distribution of Projects	
Trend of Completions and Cancellations	
Trend of Various Schedule Factors	
2. Scheduled Construction Progress	124
Installing Intervals	
Rates of Progress	
Jobs Overdue	
Comparative Yearly Performances	

Chapter X

Studies of Planning and Inspection Performances	129
1. Planned Man-Loads for Projects	129
Over-run and Under-run of Planned Appropriation	
Complaints	
Weekly Record of Planning	
2. Efficiency of Inspection Force	133
Weekly Record of Inspections	
Ratios of Inspections to Total Jobs	
Ratio of Rejections to Acceptances	
The Significance of These Factors	

Chapter XI

Miscellaneous Studies	139
1. Stock Subscription, Insurance and Savings	139
Degree to which Employees are Subscribing	
Relative Group Showings	
Comparative Years' Subscriptions	
Monthly Trends	
2. Training Opportunities	142
Percentage of "First-Aid Graduates	
Progress in Technical Training	

Contents - 5

	<u>Page</u>
3. Survey of Accidents and Sickness	144
Summary and Causes of Accidents	
Ratio of Accidents to Working Man-Load	
Trend of Disability Costs	
Relative Proportions of Sickness and Accidents	
 Chapter XII	
Conclusion	152
1. The Indisputable Value of Research and Statistics	154
Disclosure of Radical Precedents	
Forewarning of Pitfalls	
A "Finger on the 'Pulse' of Operations".	
2. Prospective Future	156
Increasing Use of Statistics	
Improving Facilities for Research	
The Recognition of Its Value	

The End

Bibliography

List of Illustrations

	<u>Page</u>
Growth in Telephones 1900-1928 Inclusive	17
Routing of a Telephone Call	21
Picture of "A" Switchboard	22
Picture of Call Indicator Position of Switchboard	26
Picture of Typical Selector Frame	28
Rear View of "A" Switchboard	31
Payroll Trend Chart	41
Chart on Payroll Sub-divisions	44
Bar Chart on Manload, Payroll, and Average Earnings	46
Trend of Field Manload	49
Table A - Manload Distribution By Divisions	52
Chart on Residential Classification of Manload	54
Resident Labor Distribution Chart	56
Chart Comparing Resident Manload with Manload Used	60
Table B - Composite Personnel Study	63
Educational Classifications Chart	65
Table C - Frequency Distribution of Salaries	66
Service and Age Chart	67
Salary Distribution Chart	69
Salary, Age, and Service Applied to Individual Man	71
Analysis of Operating Cost Chart	75
Comparative Divisional Operating Cost	78
Table D - Analysis of Costs Monthly	79
Relation of Comparative Costs Chart	81
Labor Trend and Analysis Chart	84
Proportions of Maintenance Labor	86
Maintenance Labor Trend	87
Analysis of Paid Time	89
Analysis of Lost Time	90
Divisional Proportions of Labor	93
Increasing Labor Efficiency Chart	95
Trend of Overtime	97
Custom Work Occurrence	99
Value of Equipment Installed per Man-week	102
Bar Chart of Cost per Frame	104
Cost per Section Bar Chart	105
Table E - Analysis of Overhead Monthly	110
Voucher Analysis Chart	112
Voucher Cost by Divisions	115
Table F - Proportions of Large and Small Projects	118
Chart on Total Current Jobs Weekly	119
Trend of Estimate Completions and Cancellations	121
Trend of Schedule Factors	123
Installing Intervals and Rates of Progress	125

Illustrations - 2

	<u>Page</u>
Circle Chart on Several Years' Performance	127
Planning Performance Chart	131
Table G - Under-run and Over-run of Appropriations	133
Table H - Weekly Inspection Facts	134
Chart on Inspection Facts Weekly	136
Bar Chart on Inspection Facts (Three years)	138
Table I - Stock Subscriptions	140
Trend of Payroll Deductions (Bank, Insurance, and Stock)	141
Four-year Comparison of Stock Purchases, First Aid and Foreman Training Activities	143
Table J - Summary of Accidents	146
Extract from Magazine, Summarizing Accidents	147
Magazine Extract, Showing Several Years' Accidents	148
Trend of Disability Payments	150

PART ONE

CHAPTER I

Introduction

In the history of the World we have experienced, or have learned about, transitional periods of advancing civilization. From the earliest stages of life, man has been unique. He has devised ways and means of livelihood with the least possible effort and discomfort, crude and blunderingly at first, but becoming more and more intelligent as time went on. Man has distinguished himself from the other animals by the use of his superior brain, and has assured an unassailable prestige for his claim to rule the World. All through the ages he has learned to utilize the things and beings around him, to his own advantage.

The changes in the Old World were comparatively slow, to our modern way of thinking, but we realize that although the readjustments in man's life centuries ago were few and far between, they have constantly gained momentum. It has been necessary for man to adapt himself to new and changing environments from time to time, and the survival of mankind has depended upon his ability to so adapt himself and to foresee possible

hardship or disaster. As the occasion for readjustment arose, he has not been delinquent, at least, not to a degree bordering anywhere near disaster to the race.

The first real cognizance of the fact that economic changes were vitally affecting man's welfare, came about the time of the Industrial Revolution, and until then, industry was a slow-moving but sufficient means of livelihood. The need then for greater production and activity caused people to jar themselves loose, so to speak, and to keep step with times. One improvement naturally led to another and so the momentum increased as the minds, now alert to possibilities, began to donate something to science and society. Man might be said to have had three great industrial periods in his life: the appropriative period; the adaptive period; the creative period.

As a result of man's creative genius, business has grown in modern times to such a magnitude that it would have divested itself of human control if it were not governed intelligently. Progressive minds have been aware for some time that intelligent analyses are necessary in the conduction of large-scale activities of any sort. This was realized long ago when the need for statistics became apparent. In fact, long before business circles conceived of the value of this

science, it was in demand by political, civic, and theological organizations. When populations became large, it is only natural that the political leaders were curious to know the exact numbers to which the communities were expanding. Churches were likewise interested in knowing the extent of their followings. As governmental and civic commissions prepared to attack problems confronting them, they needed data of various kinds upon which to base their assumptions and conclusions. Is there anything more natural than the inception of statistics in the commercial and financial fields also?

The science of statistics is the chief instrumentality through which the progress of civilization is now measured, and by which its development, hereafter, will be largely controlled. Until this science was evolved, history was little more than tradition transcribed. Within the short period of time this new science of statistics has been so effectively organized, a new horoscope of the future has been afforded, surpassing any heretofore derived from any other agency. Statistical surveys, although at first largely census and mortality problems, have branched into broader economic and commercial fields, until today, when statistics are compiled for practically every commercial and administrative function. In fact, there is no field of endeavor into which our ambitious statisticians dare not enter.

The use of this science is not only confined to the general commercial field in business but is now very common in its use internally by practically all of the progressive concerns. The old, intuitive method of determining business methods and policies is gradually being replaced by fact-finding and research because modern business is becoming too complicated for guesswork. There is a growing realization that the formulation of successful management methods and policies must be based on the accurate and thorough collection, organization and interpretation of facts. Business executives are turning more and more to the science of statistics as a means of obtaining the true picture of their performances, and as an aid in formulating future methods and controls.

Statistics, as we use them today, is a comparatively new science although its history in the United States dates back seventy-five years to 1839, at which time the ⁽¹⁾ American Statistical Association was founded. At that time there was but one similar organization in existence. This was the London Statistical Society, now the Royal Statistical Society, founded four years earlier.

(1) The American Statistical Association, by John Koren, Pres. 1914. The MacMillan Company, New York.

It is probably well to quote John Koren, American Statistical Association, President of 1913 and 1914, in our desire to trace the history of statistics in the United States. This Association being the pioneer statistical organization of the Country, should serve as the best possible field for extracts of history.

"The objects of the Society shall be to collect, preserve and diffuse statistical information in the different departments of human knowledge. The by-laws provide, among other things, that the operations of the Association shall principally be directed to the statistics of the United States; and they shall be as general and as extensive as possible and not confined to any particular part of the country..... The labors of the Association may embrace all subjects. The by-laws also planned for a statistical library and stated that efforts to diffuse statistical information shall be made by printing and publishing circulars, reports, a periodical or occasional volume.

Thus seventy-five years ago the fair enterprise was launched by a little band of enthusiasts who labored diligently to inform themselves and others, and who, looking forward with rare courage to the things to be, rather than to the present, wrote about the Science of Statistics, always spelling it with a capital S. At that time the professional statistician was not, and the statistical output almost negligible.

Even in its early stages the Association lacked that parochial flavor which some have imputed to it. It was not preoccupied by local affairs or wasting time in self-admiration over Massachusetts, men or things. At the very outset contact with a larger world was sought through its foreign corresponding secretaries, and within a year it counted corresponding members in about a dozen states. At the first quarterly meeting it reached out beyond the United States by electing foreign members, the first of whom was the foremost statistician of his day, Adolphe Quetelet.....

Year by year the same small group, usually under a dozen, regularly attended the four quarterly meetings, encouraging each other to original effort in statistical work and garnering diligently helpful knowledge from various sources. Nothing testifies more eloquently to the statistical poverty of the time than the publications collected as the beginnings of a library. Among the works donated we find mention of Pitkin's 'Statistical View', Hazard's 'Statistical Register', 'Bills of Mortality of Philadelphia from 1820 to 1839', by Dr. Henry Bond, the few volumes of the United States Census, schedules for taking the census, statistical forms and questions used by the Statistical Society of London, forms used in France for the registration of births, marriages and deaths, unnamed statistical tables of Massachusetts by A.W.B. Peabody, etc.....Not all who dived into the uncharted statistical seas brought up a perfect pearl. Some of us fail to do so now. Yet solid contributions to knowledge were made.

Meanwhile, the Association sought larger fields. From the beginning it became closely identified with the affairs of the United States census.....Other branches of the federal government occasionally sought the help of the Association. Particularly was this true of the Treasury Department. In 1845 its secretary requested the Association to aid him in preparing his report to the next Congress. The Commission on Education also drew upon the services of the Association.

Although the Association from the beginning had sought touch with European statistical affairs, it was not until 1860 that an opportunity presented itself for participation in an International Statistical Congress, the one held in London that year.....

Let others record the most recent history of the Association.....We are vigorous in membership and lack not for interest. Never has opportunity for intelligent effort been greater. The statistical world about us is immense and widening; but not altogether well-ordered. There is constructive work to do before the statistical service, national as well as local, can reach the plane to which it belongs. There are standards to be set and to maintain. If there are among us a multitude of indiscriminate consumers of statistics, it must be that there are too many indiscriminate producers. It is not a part of our mission to apply a remedy against the prevalent statistical myopia which prevents a view of a wide horizon, and against the no less common statistical astigmatism, the victims

of which see things, to be sure, but not always in their true relations? Perhaps statistics will always remain the plaything of some immature minds, and be used by others as a convenient springboard from which to jump at fallacious conclusions. But if the past carries any assurance of the future, may we not look forward to a time when the profession of statistics shall have come fully into its own, and when it will be recognized that the instrument at its hands has but the supreme purpose of searching for and diffusing human knowledge?"

While the history of statistics, as we have considered it so far, has shown the seriousness of mind regarding its progress, it is by no means the record of its earliest uses in the history of the World. If we were to trace it back to its birth we would find that data were compiled by the ancient Egyptians as far back as 3050 B.C. when information on population and wealth was gathered preparatory to the building of the pyramids.¹ Records of statistical works were found in China 2300 B.C. In Greece a census was taken in 594 B.C. for tax purposes. It is a known fact that the Romans excelled all others in their desire for definite measurements. In view of these facts we trace statistics to the very ancient periods. The best known census of the Middle Ages was the "Domesday Book" prepared by order of William the Conqueror to acquaint the sovereign with the extent of his new dominion (1088 A.D.)

¹ Encyclopedia Americana, Vol. 25, Page 536.

As each year passes the use of statistics is becoming more and more popular, and this is especially true of recent times when statistics are compiled and used for practically every large-scale activity. Noteworthy contributions to this science are being made by various organizations, such as: insurance companies, banking houses, national sociological and philanthropic societies. The insurance companies especially have done remarkable work in studying the health conditions in various parts of the world.

Progressive statistics has been definitely fostered in practically every enterprising nation on the Globe, foremost of which (in taking them alphabetically) are: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Great Britain and Ireland, Hungary, India, Italy, Japan, Netherlands, Norway, Russia, Sweden, and the United States.

It is not necessary to our purposes at this time that we go any deeper into the history of statistics, and the foregoing historical information should suffice in gathering a general knowledge of the progress of this science in the past. The brief history given here is, of course, only incidental to the real purpose of this thesis. We need only to add that the use of statistical methods has extended to internal use in recent years, where it is a tool of the management, even to departmental functions.

CHAPTER II

Classification and Description of Data

The collection of statistical data for studies is only the first step in the employment of statistical methods. Quantitative material is essentially required in compiling these data if the best and truest results are to be obtained. In fact, no true example can be expected from any mass of items unless the collection is sufficiently exhaustive to include the widest possible variation.

It is not sufficient to merely amass a large quantity of facts. Numerical data, to be useful for scientific purposes, must be arranged in classified form. The kinds of classifications to be used in any study, depend upon the desired information and the same data can be classified and reclassified in a great many ways, i.e., race, color, sex, age, etc. Further than this, it can be simplified by grouping in intervals, for example: 1 to 10 and 10 to 20 and so on, making the mass of data more wieldy. In this connection, it should be explained, that it is relative, and not absolute accuracy which is important. Absolute measurements in some kinds of data cannot be

1. Introduction

The following is a summary of the results of the investigation.

The first part of the investigation was devoted to the study of the properties of the function $f(x)$ defined by the equation $f(x) = \int_0^x f(t) dt$. It was shown that $f(x)$ is a continuous function and that it satisfies the differential equation $f'(x) = f(x)$. The second part of the investigation was devoted to the study of the properties of the function $g(x)$ defined by the equation $g(x) = \int_0^x g(t) dt$. It was shown that $g(x)$ is a continuous function and that it satisfies the differential equation $g'(x) = g(x)$.

The third part of the investigation was devoted to the study of the properties of the function $h(x)$ defined by the equation $h(x) = \int_0^x h(t) dt$. It was shown that $h(x)$ is a continuous function and that it satisfies the differential equation $h'(x) = h(x)$. The fourth part of the investigation was devoted to the study of the properties of the function $k(x)$ defined by the equation $k(x) = \int_0^x k(t) dt$. It was shown that $k(x)$ is a continuous function and that it satisfies the differential equation $k'(x) = k(x)$. The fifth part of the investigation was devoted to the study of the properties of the function $l(x)$ defined by the equation $l(x) = \int_0^x l(t) dt$. It was shown that $l(x)$ is a continuous function and that it satisfies the differential equation $l'(x) = l(x)$.

actually made and some countings are frequently only approximations. The most delicate instruments for measure merely make possible a greater degree of precision than do some of the other more crude tools, and it must be remembered that the most delicate is not always available. At times, a high degree of precision, though attainable, may be a waste of effort, especially in the study of large-scale propositions, such as; coal consumption, wheat production, rainfall and other such prodigious quantities. This does not mean, however, that accuracy is not essential to statistical work. On the other hand, accuracy is probably the very first law of statistics and without it, the use of statistics would be a simile of a good weapon in the hands of a maniac. What we must do, then, is distinguish between accuracy and minute precision of an unnecessary degree.

When one deals with masses of data the problem is one of condensation and analysis, in order to present in concentrated form, material representative of wide and varied functions. The first step, in this presentation in concise form, is tabulation. The compact story given on these tables is frequently the summation of probably thousands and even millions of units. It is the function of tabulation to

classify, arrange and summarize, in easily accessible form, a wide diversification of items. The table can be so arranged as to emphasize comparisons, display relative values, and uncover any flagrant divergence or fluctuation.

In the collecting, sorting and summarizing of data for statistical tables, modern progressive organizations have resorted to mechanical devices, which perform most of the slow and mechanical preparatory operations, leaving the energy of the statistician free for composing and analyzing studies. Considering the purpose of this thesis, it is not necessary to go into details on these mechanical methods of tabulation, only to say that they serve as an expedient in dealing with numerical and quantitative facts of a limited variety.

Many concerns are satisfied with, and often prefer the table as the finished study. Others, however, desire the data in graphical form, in order that they will have thrown into relief significant facts and their relations. The graph serves to bring out potent or delinquent conditions in very vivid form. It is an invaluable aid as a means of portrayal by reason of the fact that it gives a picture at a glance, whether the quantities be absolute or relative. Moreover, the graphical chart emphasizes significant facts

not readily apparent in tables of figures. It captures attention and by accentuating points of interest it entails no great sacrifice of time. The busy executive welcomes the graphic representation, which, incidentally, can be accompanied perhaps by the original data in tabular form. Several graphical charts will be shown later in this thesis.

Something should be said about the construction of charts and the possibility of error. Like all other reading matter, they must be sufficiently standardized in form to permit of universal use. Because of its universal use by firms and societies of dissimilar data it has been very difficult to secure standardization of practice. As a means of solving the problem, a joint committee composed of representatives of the various groups prepared a report¹ recommending the employment of certain standard methods of graphic representation. As far as can be ascertained these rules, which we need not enumerate, are being popularly adhered to in all good statistical work.

It is not the author's intention to attempt a treatise on the general science and application of statistics, for such

¹ Quarterly Publications of the American Statistical Asso., Vol. 14, Pp. 790-797 (1915)

an exhaustive subject could never be enclosed within, or even satisfactorily fettered to, the space and time limits of this thesis. These points, such as the one just mentioned on faulty construction of charts, are given in passing merely to acquaint the student and layman with the fact that there are possibilities of fallacious interpretation because of errors in drafting.

Fallacies are not merely confined to the drafting of charts in statistical work. Errors are very probable in tabulating and in comparing non-comparable data. Sound facts are frequently made the basis for unwarranted inferences. Studies cannot be made of a few, or special classes and be rightfully claimed as a fair universal showing. Percentages will be very often misleading if they are not computed from a fair representative group. Suppose we were to say that thirty-three and one-third percent of the girls in a certain office had resigned in one day. How ambiguous that is! If the total number of girls was known, we would find that there were only three girls there and that one had resigned.

Statistical methods, as a tool, require intelligent usage, and the results require intelligent interpretation. Without due care and diligence in the preparation and interpretation of data, statistics might truly be misused.

PART TWO

Chapter III

The Telephone Central Office

At this time it is probably well to devote a chapter to a brief history of the development of telephone service and the evolution of the Central Office. Some knowledge of this subject will be essential to the reader because the statistical studies in this thesis are made almost entirely on the construction of Central Offices. Probably the best and most concise way to show the earlier advance of the industry will be to present a chronological list of steps in its growth. The following information is taken from "The Magic of Communication", by John Mills - Information Department, American Telephone and Telegraph Company.

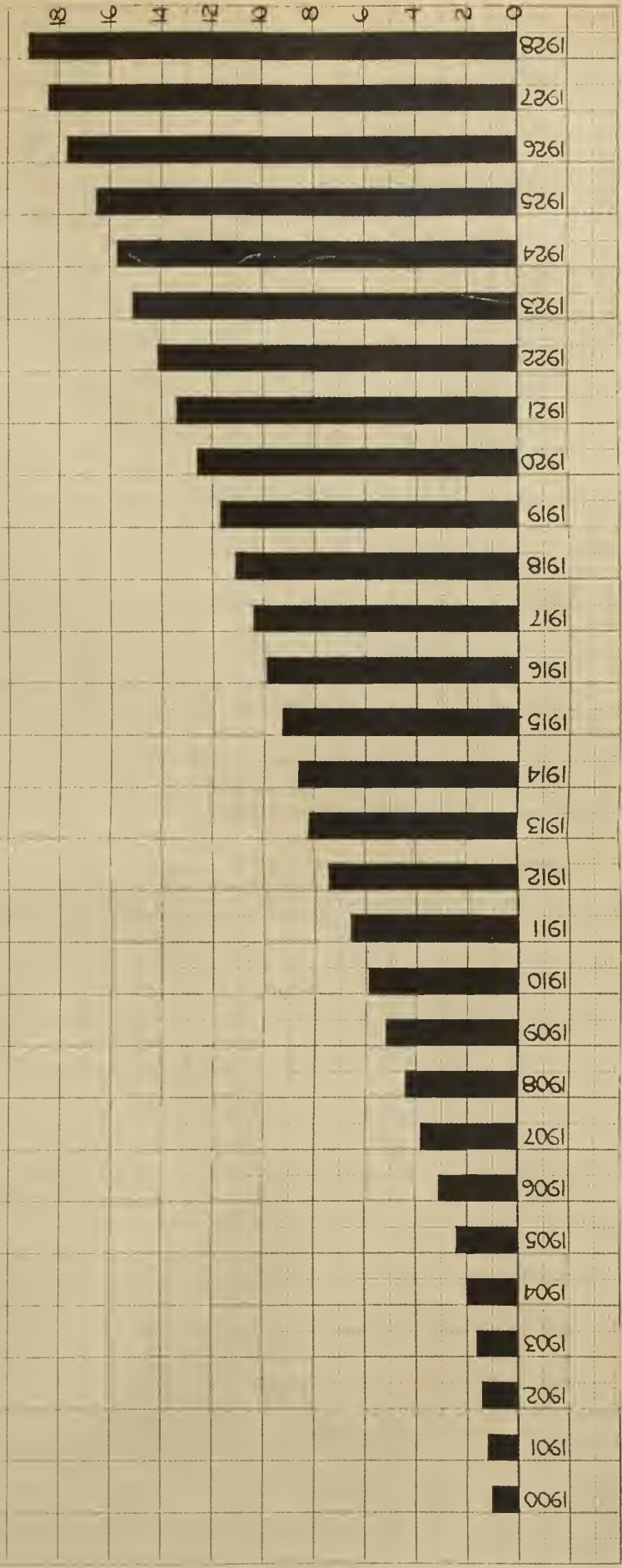
- 1875 First words transmitted by Telephone.
- 1876 First complete sentence transmitted by telephone.
First conversation by overhead line, 2 miles -
Boston to Cambridge.
- 1880 Conversation by overhead line, 45 miles - Boston to
Providence.
30,872 Bell telephones in the United States.
- 1881 Conversation by underground cable, 1/4 mile.
- 1884 Conversation by overhead line, 235 miles - Boston to
New York.

- 1890 211,503 Bell Telephones
- 1892 Conversation by overhead line, 900 miles - New York to Chicago
- 1900 676,733 Bell Telephones owned and connected
- 1902 First conversation by long-distance underground cable, 10 miles - New York to Newark
- 1906 Conversation by underground cable, 90 miles, New York to Philadelphia
- 1910 5,882,719 telephones in Bell System
- 1911 Conversation by overhead line, 2,100 miles, New York to Denver
- 1913 Conversation by overhead line, 2,600 miles, New York to Salt Lake City
Conversation by underground cable, 455 miles - Boston to Washington
- 1915 Conversation by transcontinental line, 3,650 miles - Boston to San Francisco
Speech transmitted for the first time by radio telephone from Arlington, Va., across the continent to San Francisco, over the Pacific to the Hawaiian Islands, and across the Atlantic to Paris
- 1920 12,601,935 telephones in Bell System
- 1921 Conversation by deep sea cable, 115 miles - Key West, Fla., to Havana, Cuba.
First conversation between Havana, Cuba, and Catalina Island by submarine cable, overhead and underground lines and radio telephone - distance 5,500 miles.
Extension of Boston-Philadelphia cable to Pittsburgh - total distance 621 miles.
President Harding's inaugural address delivered by loud speaker to more than 100,000 people.
Armistice Day exercises at burial of unknown soldier delivered by means of Bell loud speaker and long lines to more than 150,000 people in Arlington, Va., New York, and San Francisco.
- 1922 Ship-to-shore conversation by wire and wireless between Bell telephones in homes and offices and the S.S. America 400 miles at sea.
- 1923 Successful demonstration of trans-oceanic radio telephony from a Bell telephone in New York City to a group of scientists and journalists in England.
- 1924 First public demonstration of picture transmission over telephone circuits - New York and Cleveland.
- 1925 Twenty-eight radio stations linked by long distance telephone lines broadcast Defense Test Day program.

- 1926 Successful test of two-way transatlantic radio telephone.
- 1927 Radio telephone commercial service inaugurated between New York and London; later extended to all points in the United States, Cuba and Great Britain and certain points in Canada.
- First Public Demonstration of Television or Distant Seeing.
- Opening of Long Distance Telephone Service to Mexico.
- 1928 Transatlantic telephone service extended to additional points in Canada and Mexico and to all of Germany, Switzerland, Belgium, Spain and the Netherlands, as well as Paris, Copenhagen, Stockholm, Oslo, Vienna, Budapest, Prague and other European cities and Centa, Spanish Morocco, Africa.
- Joint meeting of American Institute of Electrical Engineers in New York and British Institution of Electrical Engineers in London by means of transatlantic telephone.
- 1929 More than 19,000,000 telephones in Bell System.

Considering the information given above, we must readily agree that the development of the telephone industry has been tremendous since its birth. Its steady and rapid increase is portrayed graphically on page 17. As its scope and equipment magnified, all of its constituent parts naturally needed adjustment and support in order that they be able to keep step with the progressive advance. In the early stages of commercial use, telephones were leased to the public in pairs. The lessee constructed his own telephone wire to connect his instrument with that of a friend or neighbor, or ran his line between his home and his place of business. It was impossible, in that stage of development, for a lessee to talk with any other individuals in his community, who like himself, had leased a pair of instruments.

GROWTH IN NUMBER
OF TELEPHONES
(MILLIONS)



It was at this stage that the first evidence of the telephone Central Office presented itself. The introduction of the telephone switchboard, although at first very simple, developed later into the Central Office. It was the development of the switchboard that made possible the interconnection of individuals and of communities, and thus broadened the telephones' usefulness to the public. The real valuable feature of the telephone today is the fact that it can be connected with any one of more than 18,000,000 other telephones. The central office system of service makes this possible. It might rightfully be referred to as the "heart" of the service.

¹ The first telephone switchboard actually installed for regular business communication was situated in Chapel Street, New Haven, in 1878. From that time on several others were installed, and as the demand for telephone service grew, it became necessary to increase the size and capacity of the switchboards. The early switchboards accommodated little more than half-dozen subscribers on interconnections. Later models alleviated the difficulties for a time, but with the increase of subscribers and the correspondingly greater increase in

¹ The Telephone and Telephone Exchanges, J.E.Kingsbury, Longmans, Green & Co. 1915

calls, a serious problem presented itself. The number of subscribers to which one operator could attend under the conditions then prevalent was usually limited to twenty-five and rarely exceeded fifty. The solution was found by giving to each operator a means of access to every subscriber's line - that is to say, by multiplying the points of access. The invention of the multiple switchboard served to fill this need.

The multiple switchboard gets its name from the fact that each subscriber's line terminating at the switchboard is duplicated on every section of the board. For instance, a switchboard having a capacity to serve 5,000 lines and consisting of 10 sections has ten times 5,000 or 50,000 points of connection. In this way an operator can connect any calling subscriber with any one of the 4,999 other subscribers' lines terminating at the switchboard.

A single central office can accommodate only a limited number of subscribers, the largest offices being designed to take care of 10,500 lines. In a large city there are thousands of subscribers and it is necessary to provide a number of central offices with facilities for interconnecting each office in order that subscribers of one central office may

talk with subscribers of another. This necessitates trunking the calls from one office to the other over cable pairs used especially for this purpose.

It is the usual practice to terminate the subscribers' lines in a separate switchboard from the trunks, the board in which the subscribers' lines terminate being known as the subscribers' or "A" switchboard, and the board in which the trunks terminate being known as the trunk or "B" switchboard. The figure on page 21 shows schematically the routing of a call from the "A" board to the "B" board, the "A" board being located in the originating and the "B" board in the terminating office. Following this sketch, will be found a picture of an "A" switchboard with the various parts clearly marked.

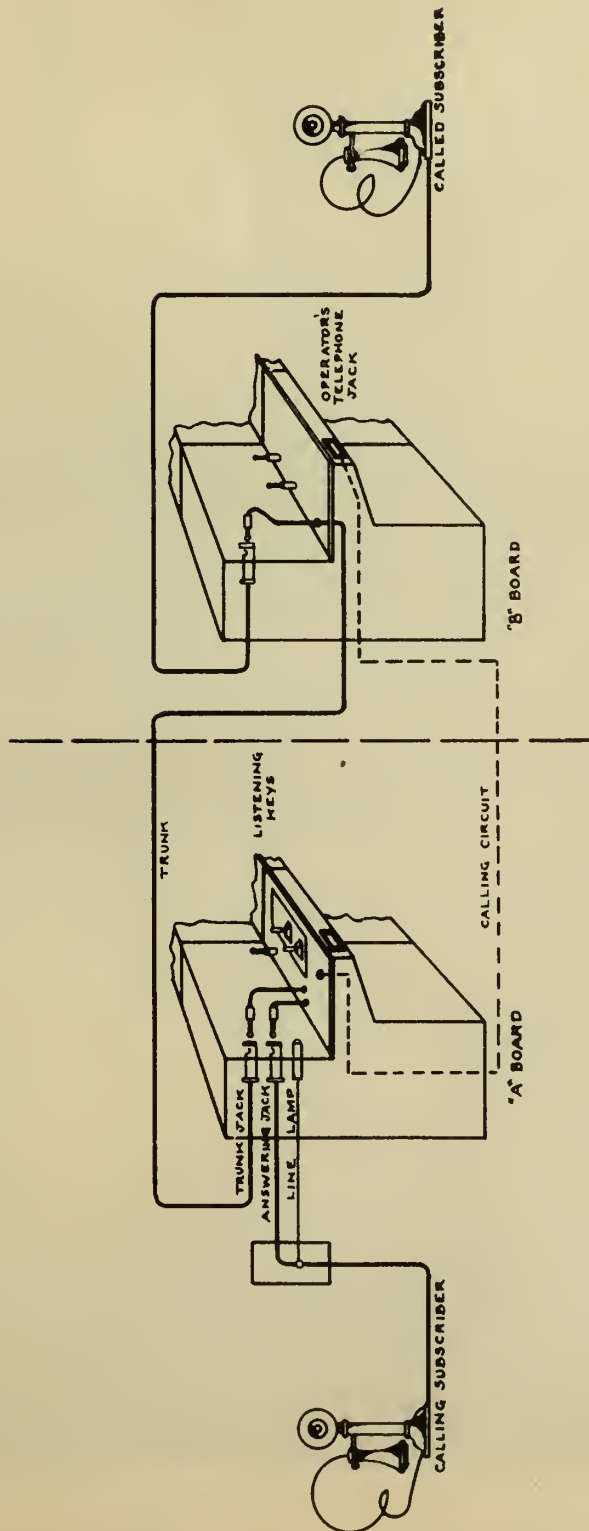
New features are being introduced in all the various types of central offices, from time to time, but the explanation of the technicalities of these things plays no part in this thesis only as a passing comment serving to bring out the complicated nature of central office installation. This will be more minutely covered in the following chapter wherein the different types of offices and their outgrowths will be discussed.

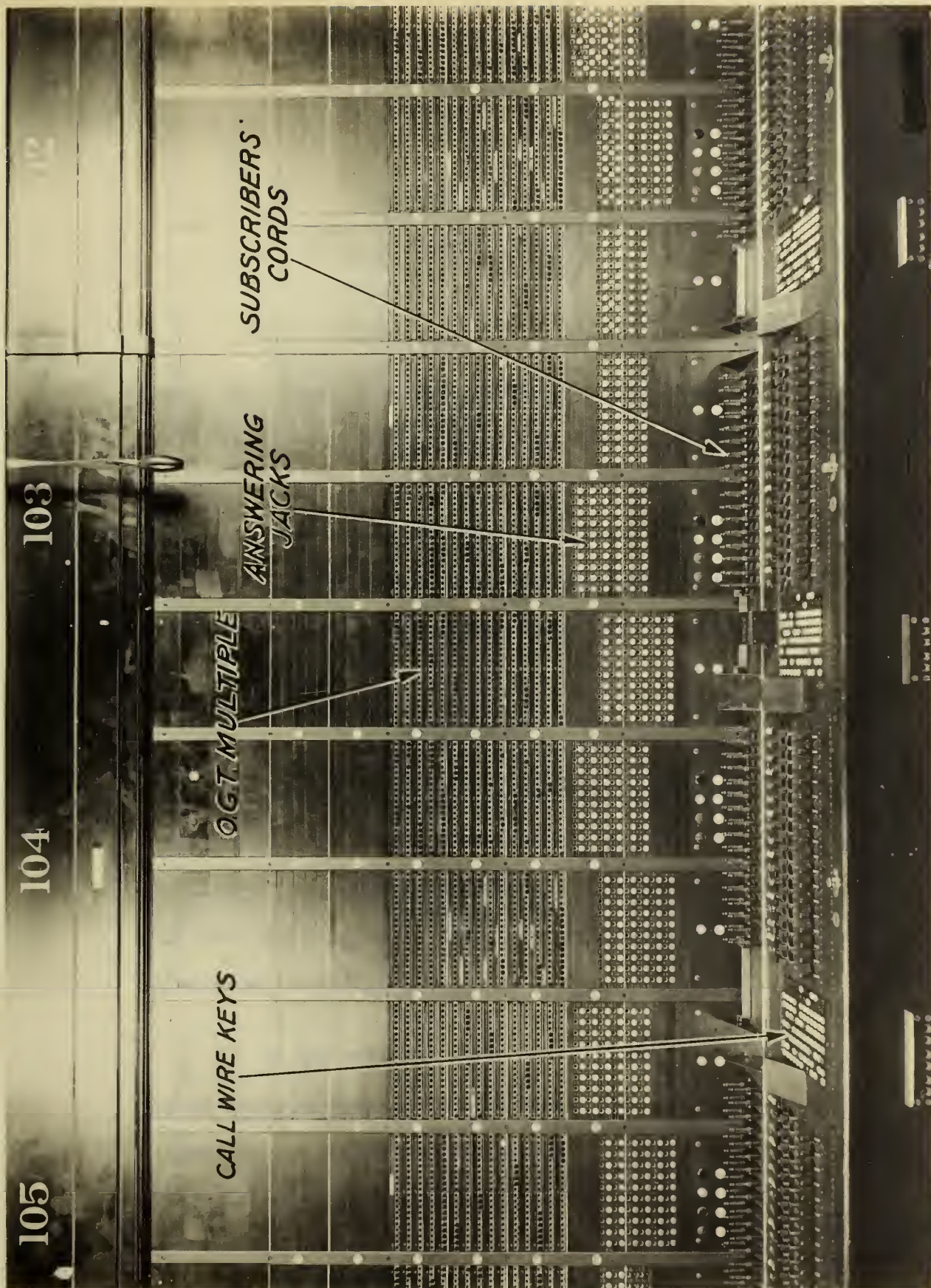
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CHAPTER III (continued)





105

104

103

102

CALL WIRE KEYS

OGT MULTIPLE

ANSWERING
JACKS

SUBSCRIBERS'
CORDS

CHAPTER IV

Types of Central Offices

There are fundamentally three types of Central Offices, viz: Magneto, Common Battery, and Machine Switching. Of these, the latter two are now most commonly used, while the Magneto type is tending toward obsolescence. Like all other things subject to the exactions of rapidly increasing demand, the early Magneto office has been superseded, except in small communities, by the Common Battery system.

The Common Battery system is so called because it has the electrical energy for all purposes concentrated at some one place, usually the Central Office, common to all points of service. In the case of the Magneto type, however, the current is supplied at the subscriber's set by local batteries and generator, and the turning of a crank provides the current for ringing.

In the earliest days the difficulties of the telephone system were incident to service only. The development of new devices to accomplish new and better service, and the application of new methods to accommodate the rapid increase in subscribers, kept the pioneers very busy. Little thought then could be allotted to expected and potential future development. The

plant was constructed at first with little or no provision for future growth, and consequently, when the necessity for expansion arose, costly replacements were inevitably necessary.

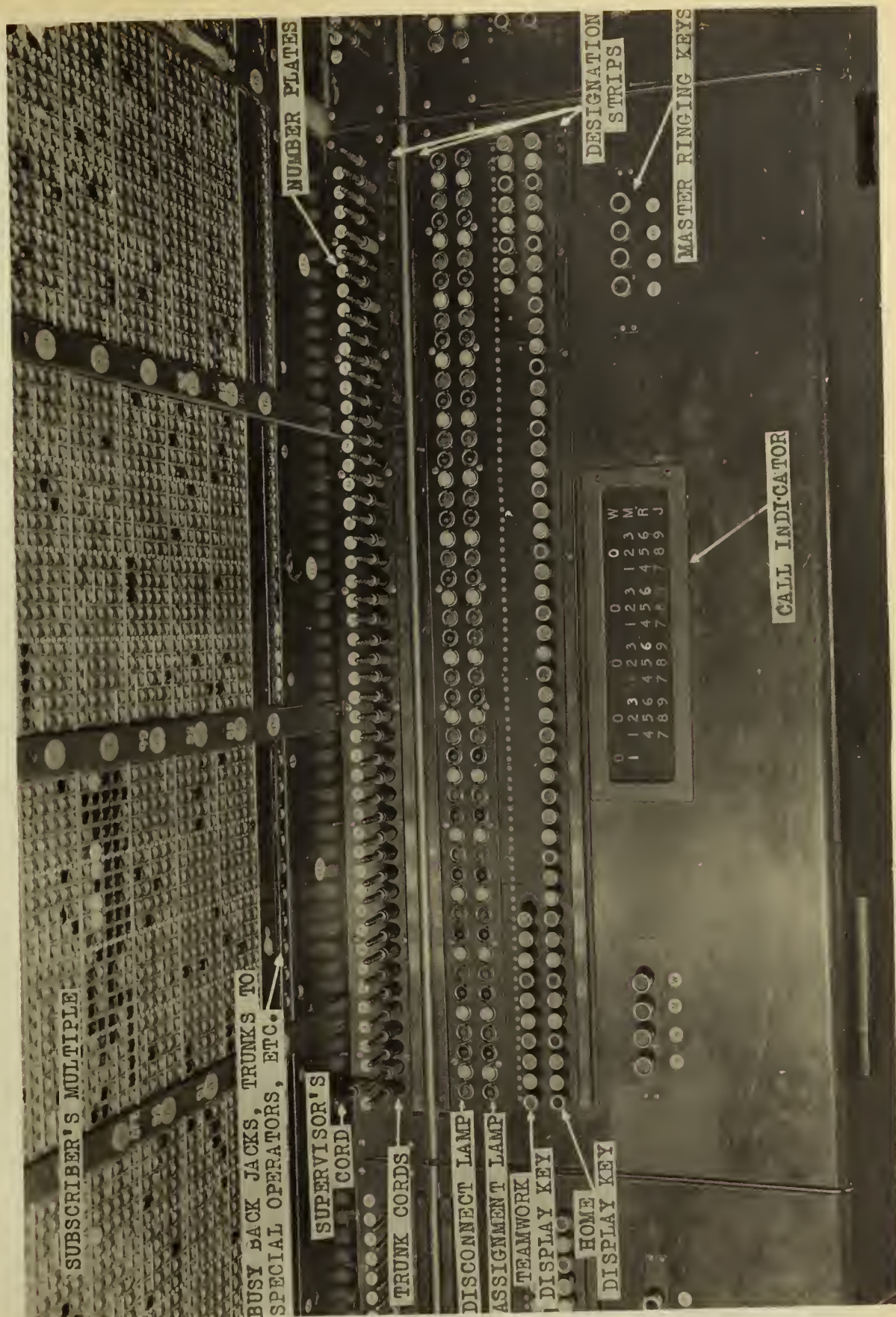
The Common Battery or "Manual" Office of today is experiencing the introduction of new features every now and then, but it is so constructed that a complete replacement is seldom, if ever, necessary. The "Manual" Office, so-called because of the human attention necessary to its complete operation, is the most common type today, although a new mechanical type has been introduced in different areas throughout the country. This is the third type mentioned above.

After exhaustive investigation and experiments extending over a period of more than ten years the engineers of the Bell System have produced an automatic switchboard which meets satisfactorily even the most exacting service conditions. Machine switching is now being introduced in large cities where economic and service conditions warrant. With the Machine Switching system the subscriber, after taking the receiver from the hook, dials the desired number at the base of the telephone instrument, the automatic switchboard apparatus performing mechanically what the operator does at the manual board. By the use of these automatic switchboards increased capacity will be provided with proportionately small increases in the number of operators required and with

a simplification of service conditions in the large and congested areas.

The Manual and Machine systems work hand in hand, so to speak, and are interconnecting in their service provision. Calls from Machine Switching to Manual offices are handled at the Manual office on call indicator "B" positions. The call progresses through a district selector and takes up a trunk which leads to a call indicator "B" position in the Manual office selected. A "birds-eye" view of this "B" position is to be found on page 26, where each feature for operation is labeled. The operator is notified that a call has reached her position by the lighting of a lamp associated with the cord in which the incoming trunk terminates. Upon perceiving this signal, she presses a display key associated with that trunk, and thereupon the called subscriber's number is displayed on a bank of numbered lamps located on this operator's keyboard. The operator then picks up the plug, tests the called line, and, if it is found idle, plugs in, or, if it is found busy, she plugs into a special jack which is arranged to send the intermittent busy tone back to the calling subscriber.

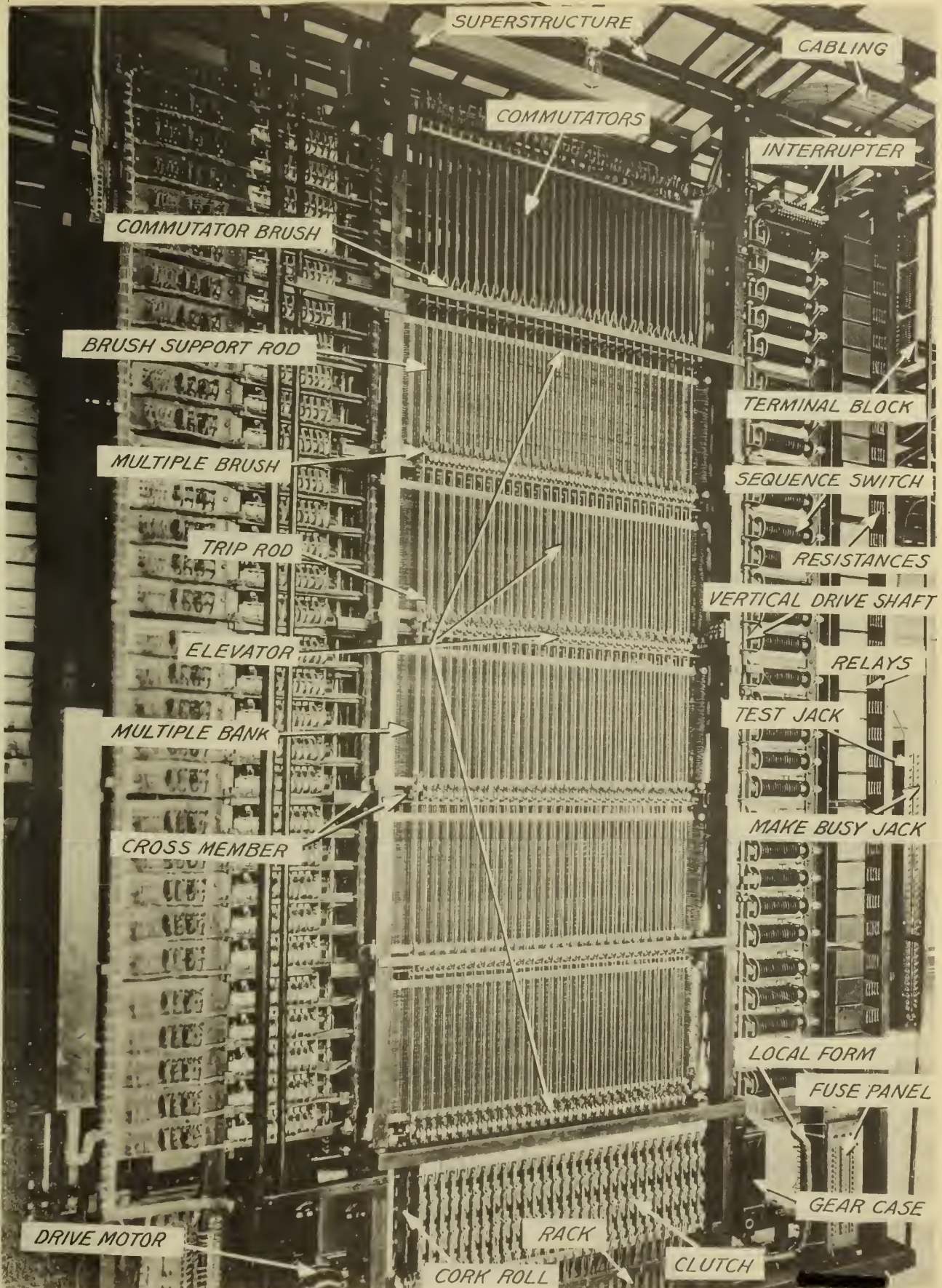
It will be readily agreed that a process, such as the one explained above, should entail the construction of considerably complicated equipment. These explanations of methods



A CALL INDICATOR POSITION

of telephone service will adequately serve to introduce the reader to the telephone systems and to the equipment installation peculiar to the Central Office part of the industry. The statistical studies and the charts therefor, appearing in later chapters, will be based upon the performance of the forces installing this particular portion of telephone plant. It is to be remembered, therefore, that this is a specialized field in construction and that the workmen are all specialists as far as general industry is concerned. The training of telephone men is essentially telephone training, distinctive by reason of its monopolistic nature. The intricacies of construction make it necessary that the workmen be telephone trained. Some idea of the complicated structure of a frame will be obtained by glancing at the picture of a typical selector frame shown on page 28.

In selecting the equipment for an office it is necessary to decide as to whether a local Magneto or a Common Battery system will be best suited to the needs of the community and also as to the relative costs of each type of equipment. In very small plants, of less than 125 lines, where there is very small prospect of a very rapid growth the Magneto system will be found to be most advantageous for use. If, however, the lines run 500 or over it is as a rule better to install a Common Battery board. Between the 125 and 500 line



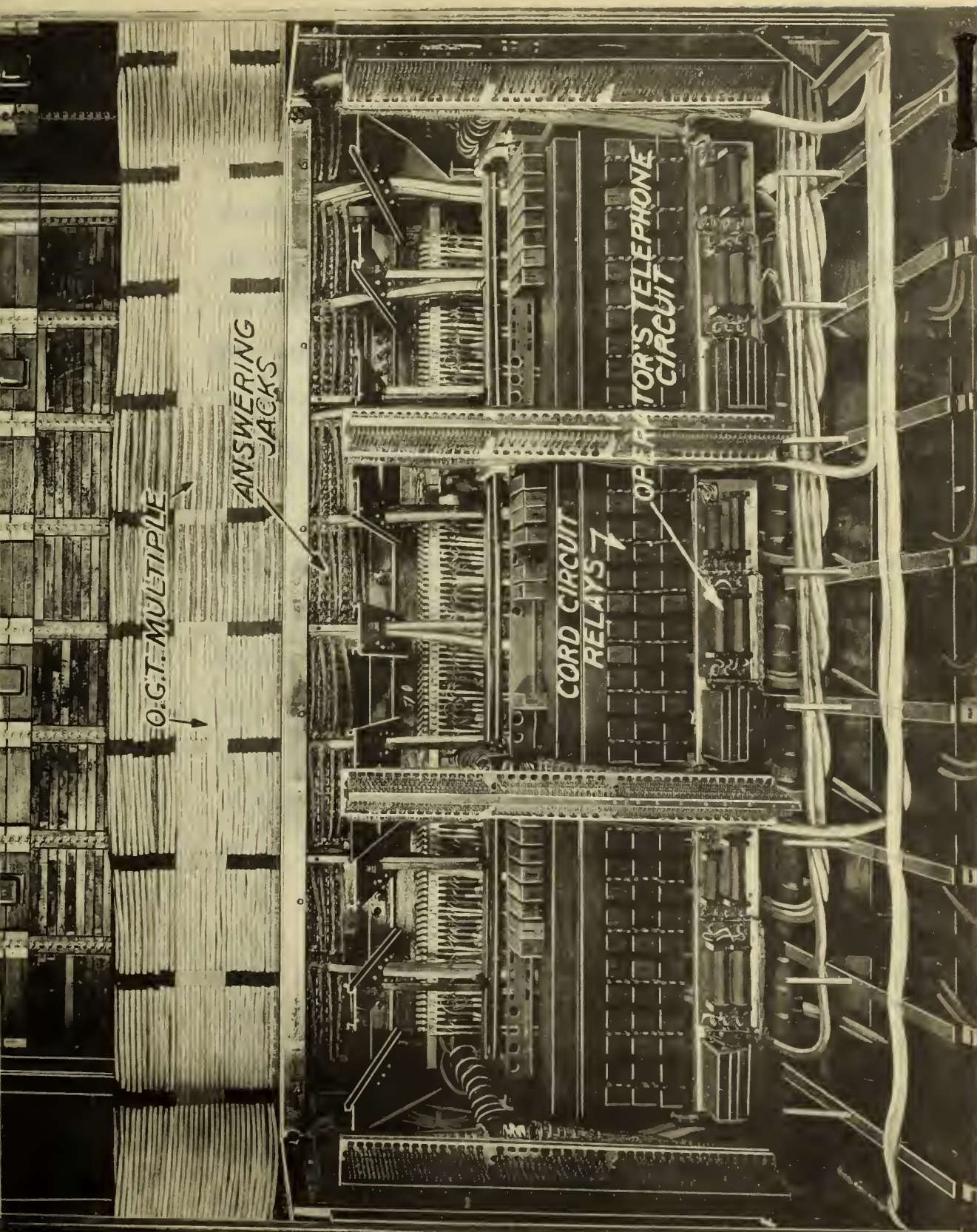
A TYPICAL SELECTOR FRAME

limits there is usually a very close question as to whether a local or a Common Battery board should be installed. This is usually settled by the prospective growth. If rapid, it will be better to install the Common Battery board, but if the growth of lines is going to be very slow, it will be in all probability better to install the cheaper local battery or Magneto type. It must be remembered, however, that no hard and fast rule can be advanced but that each specific problem must be weighed separately, and that an area where a Magneto type would prove in, might be entirely different from another area where conditions are the deciding factor, but where growth and number of lines are the same.

One of the major considerations is the nature of the community which is to be given telephone service, that is, as to whether the community is a city or a rural district. The rural lines which are short and run only a short way into the country are as a rule equipped with four party lines. The long-distance rural lines are usually equipped with a large number of telephones connected to one line. If the long rural lines form the major proportion of lines and will continue to do so for some time, a Magneto system will give the best results. It should be kept in mind that the growth of an exchange area and the ultimate service play a very important part in the layout of the telephone exchange.

The introduction of the mechanical or Machine Switching system was the culmination of development work carried on by Bell System engineers for several years. The object was to produce a mechanical central office for operation that would reduce manual operations with their attendant errors to a minimum, and at the same time meet the complex service requirements of the larger city exchange areas. The problem was a tremendously difficult one due to the size of some of the exchange areas involved and to the necessity of making provisions for inter-operation with existing manual offices.

On the occasion of a Machine Switching installation, it is necessary to make changes in all the existing Manual exchanges in the particular area, in order to permit the handling of calls to and from these mechanical offices. Such changes must be made during the period in which the mechanical exchange is being installed and they must be ready for operation simultaneously with the cut-over of the mechanical exchange. Rural lines cannot be handled on a machine switching basis, since there are usually a large number of stations per line which require code ringing. Furthermore, they must be operated on a magneto basis generally, due to the length of the lines. These lines are, therefore, terminated in the "A" switchboard in the same manner as in Manual offices.



Rear view of "A" board, giving a good idea of complicated nature of switchboard installation.

The installation of a Machine Switching system requires a longer time than is the case with a corresponding Manual system. It is larger, infinitely more complicated, and has engineering requirements that are extremely exacting. More men and longer installing intervals are necessary for the mechanical, as compared with the Common Battery or Magneto systems.

The three chief steps in the progression of telephone equipment installation have been given in the foregoing material. Under these main types of offices, there are several styles, and if studies are made later on any particular style of office under these main types, it must be understood that although the chart is labeled as a "#1 type" or "#11 type", it is merely one of the many styles under some one of the parent types explained above.

In anticipation of the specific studies to follow, enough of the telephone industry has been explained to acquaint the reader with the nature of work upon which the statistical data have been compiled. The Central Office Installation Department of the telephone industry is, independently of all other departments of the Company, equal in size and operating cost to some of the largest contracting concerns in the country. The annual operating costs of this

particular department amount to approximately two million dollars. Some idea of the magnitude and complexities of telephone installation, therefore, can be obtained by taking note of the above facts and their accompanying photographs. Is it not, therefore, apparent that condensed pictures of performance are necessary to the executive in such large-scale operations?

PART THREE

CHAPTER V

Research in Production

The enormous growth of business enterprises in recent years, with their ever-increasing complexities, has made necessary the use of some means of control which is at once scientific and economical. It is in this connection that Statistics and the Statistical Method very definitely play an important part. Intuition and guess-work are rapidly fading from the management policies prevalent today, and, in their stead, scientific research methods are becoming more and more popular. In fact, the new methods of control are not merely popular and desirable, but are indispensable to modern efficiency. Not so many years ago the majority of leading enterprises were, and could very well be, controlled by the management without any research methods, but now even if the particular firm hasn't increased very greatly in size and volume of transactions, it must recognize the methods used by its chief competitors - not intuitive, but scientific.

The policies of most progressive business organizations of today are determined on the basis of facts and to

insure the progression of these facts, adequate statistical organizations have been established wherein data can be constantly accumulated and prepared for presentation.

Although only the largest of concerns maintain the elaborate statistical organizations, smaller companies are not without the use of these fact-finding methods, if they are at all progressive. Many of the smaller firms employ only one or two research men, but the scientific method prevails there nevertheless.

There is a distinct difference between accounting and statistical records. While accounting postings and summaries will show the exact story of transactions, costs, and profits, they will not suffice as a basis for determining the trends and shortcomings of any functions, nor will they serve as a ready tool for formulating methods and policies. On the other hand statistical records are so arranged as to make available any information, from any desired angle. Business men have consequently come to realize that statistical methods of classification are necessary, and they have at the same time sought to develop an improved technique of statistical control.. It is not surprising, therefore, to find a definite trend among progressive managers to supplant intuition and guess-work with fact-finding. As a result, more intelligent use of man power, improvement in results, and a feeling of security are manifest.

Although statistical analysis is used quite extensively in the commercial field, we will confine our present interpretation of its functions and value to internal management problems, and consider it as a medium to efficiency in supervision. In this connection it attempts to set before the executive the means of detecting the development of causes, enabling him to take steps in time to make the result of the various causes advantageous, or, at least, not detrimental. As has been explained in a previous chapter, the data must be presented in such a fashion that inconsequential items will be subordinated and significant and interesting facts brought out. Some disclosures will sometimes be alarming, and so, also, will some be gratifying. The executive should welcome either. The graphical method of presentation previously mentioned portrays the picture of performance in a very clear and concise manner and it accentuates those points of interest to the reader of the chart.

Studies in performance and production are of inestimable value to the executive in controlling costs, schedules, and policies. It will readily be agreed that to search for sources of loss, a department supervisor would cause the very confusion and loss which it is sought to avoid. Hence, the value of the graph, which portrays the

performances and brings into bold relief any divergence from normal, cannot be denied.

A concomitant of the production studies in the business organization is the study on the various angles of personnel. The problems of the executive do not end with the performance functions in production. Wherever human labor is necessary in operation or attendance, the personnel factor enters into the picture for the executive and very often proves to be his chief worry. The delegation of authority and responsibility is greatly facilitated in the case of concerns knowing their personnel. Such studies as; age, service, salaries, education, and progress, are invaluable as an aid to the management in dealing with the problems of the employees, not to mention their contribution to efficiency in operation. Many of these angles will be illustrated in a later chapter together with the performance statistics mentioned above.

Considering the part statistics is playing in modern business, it might rightfully be called the "search-light", metaphorically. The function of the statistical study is likened to the searchlight, in that it lights the way and discloses the snares and pitfalls unforeseen ordinarily.

Many types of studies are possible within any organization and the figures of one survey can often be rearranged to show an altogether different angle of the work or personnel. Oftentimes a very complete and interesting picture may be portrayed with very little effort, if one knows where to obtain most easily the facts required. Many of the most progressive concerns today are keeping their records in the statistical form previously mentioned, to facilitate the collection and ready classification of data. To the executive desiring real statistics beyond the haphazard stage, this, naturally, is one of the first and most important preparatory measures.

Before passing on into the specific studies proposed, it is probably well at this time to again remind the reader that all tables and charts illustrated in connection with this thesis, are not to be considered authentic as far as the primary information is concerned. For purposes of illustration it has been necessary to create delinquent conditions which are positively mythical, in order to show the value of the particular study in uncovering inefficiency or other detrimental factors in production.

CHAPTER VI

Organization Studies

In passing from the general to the specific, we will begin with organization studies, for the organization of any large industry is essentially one of the foremost problems of the executive. No attempt will be made to cover all phases of the organization in the studies to follow, and neither will any attempt be made to exhaust all of the possibilities incident to the various other classifications throughout the balance of the thesis. However, enough of each class will be given as will serve to demonstrate the value of statistical tables and charts in promoting efficiency of supervision. It should not be necessary to show all the detailed figures from which the graphs are drawn, to serve our purpose, but in some instances where the tabulation of figures provides a good view of several angles, the table will be worthy of attention.

The Payroll

Under the subject of organization there are several items of interest, foremost of which is probably the "payroll", when one considers the magnitude and cost of the organization. When the executive thinks of the payroll he thinks of it in

terms of size, trends, and structure, usually, although there are many angles from which it can be studied. It is only natural that the general trend of the payroll, from week to week, should assume first place in the order of things when control of growth and decline is sought. The chart on page 41 shows the graphical presentation of weekly figures procured from accounting records. In glancing at this chart you will note that several payroll features have been portrayed at the same time. At the top we have the trend of payroll hours and dollars, and directly below, the trend of payroll employees. In the lower half of the chart will be found two more curves, the average weekly rate of pay, and the trend of overtime. Each of these four features tells its own story individually, and yet it is influenced by and likewise affects each of its coeval features.

In considering the significance of these curves we will commence at the top, with the trend of payroll dollars and hours. At our first glance one fact is readily apparent as we note the relative positions of these two curves. It will be noted that the hours run rather consistently above the dollars, a fact which denotes that the hourly rate of pay is below one dollar. While we find the trend of hours fairly constant, we note, on the other hand, that the dollar trend shows considerable



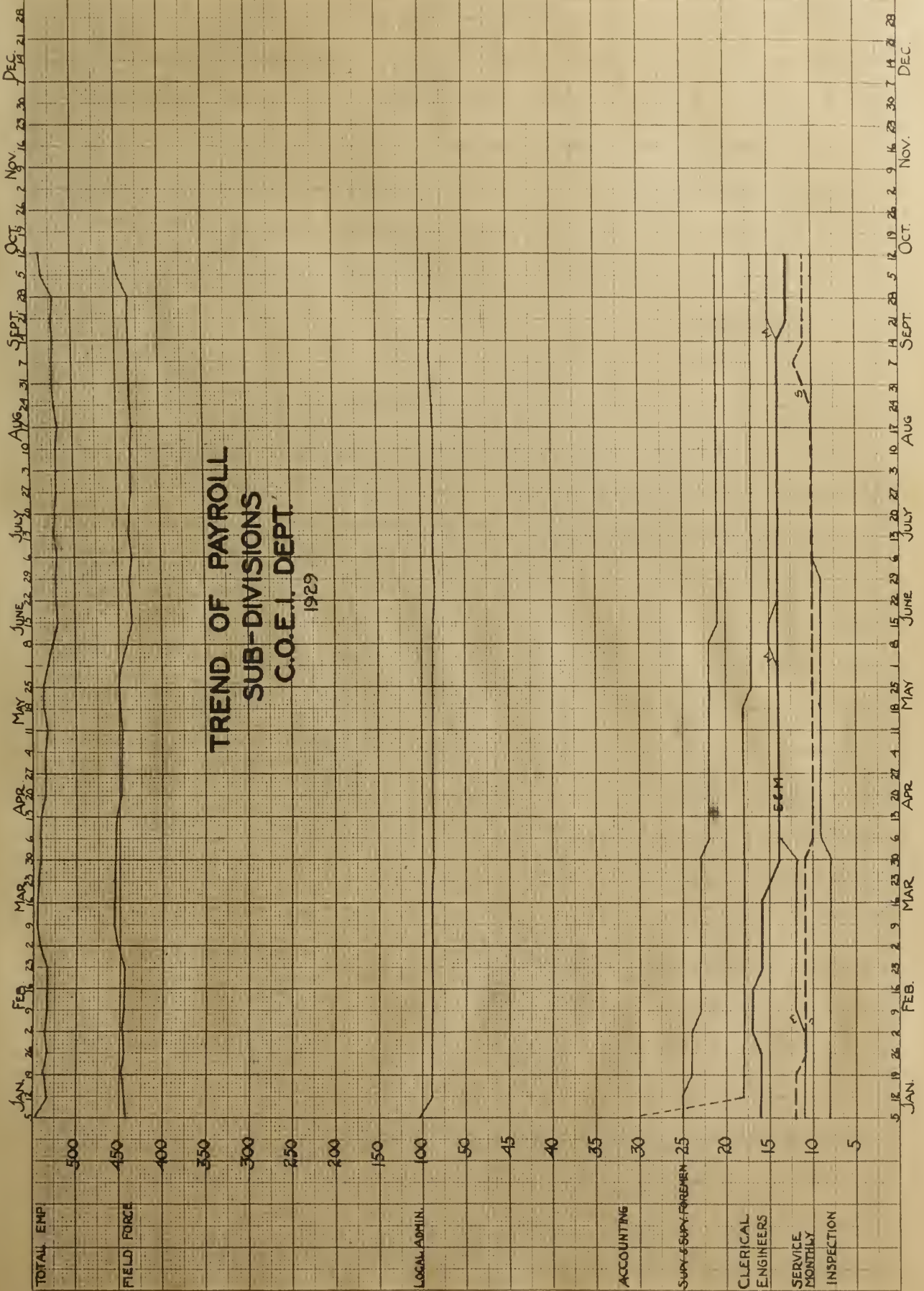
fluctuations, particularly toward the middle months of the year. This is due principally to vacations granted with pay during this particular period of the year. In granting vacations, it is the policy of the department to pay salaries in advance and consequently the curve shows a rise before the start of the vacation and a decline during and directly after vacation. Throughout the entire period, however, the hours are carried along consistently and charged to "lost-time granted", which will be explained in a later study.

The curve directly below serves as a good spot study to indicate the increase or decrease in the force from time to time. This trend should naturally follow and fluctuate in harmony with the curve above. It is interesting to note how the force curve declines until it has reached the end of September, at which time it started on a sudden rise, occasioned by the sudden employment of several new men. At this time it might be well to consider the curve next below and to explain the effect this increase in employees had upon the rate-of-pay curve. Naturally any old standing force of employees will, under normal conditions, show a gradual increase in their average rate of pay. This is prevalent here in this chart, except in instances where new, lower-salaried men were added, especially at the end

of this particular curve, where several new men were employed. It is interesting to observe the immediate effect these additions and the consequent rise in the employee curve had upon the rate curve. Of course, this is only natural because the average weekly rate is obtained by dividing the weekly payroll by the total number of employees.

In view of the fact that overtime work involves the payment of double or semi-double time it naturally inflates the payroll, and a constant surveillance is necessary to keep it at a minimum, if it is necessary at all. To aid the executive in watching its occurrence, we have plotted the curve in the lower portion of this chart of payroll features. Here the percent of overtime to normal labor is shown and from all appearances in this curve it is pretty well down, and constantly declining almost to the point of extinction. The figures for this curve were obtained by dividing the overtime hours by the total labor hours each week.

As a means of portraying the trends of the payroll sub-divisions, the chart on page 44 has been constructed. With the exception of the curve marked "field force" all of the curves represent staff employees. There is very little fluctuation in the trends of these units, as will be readily

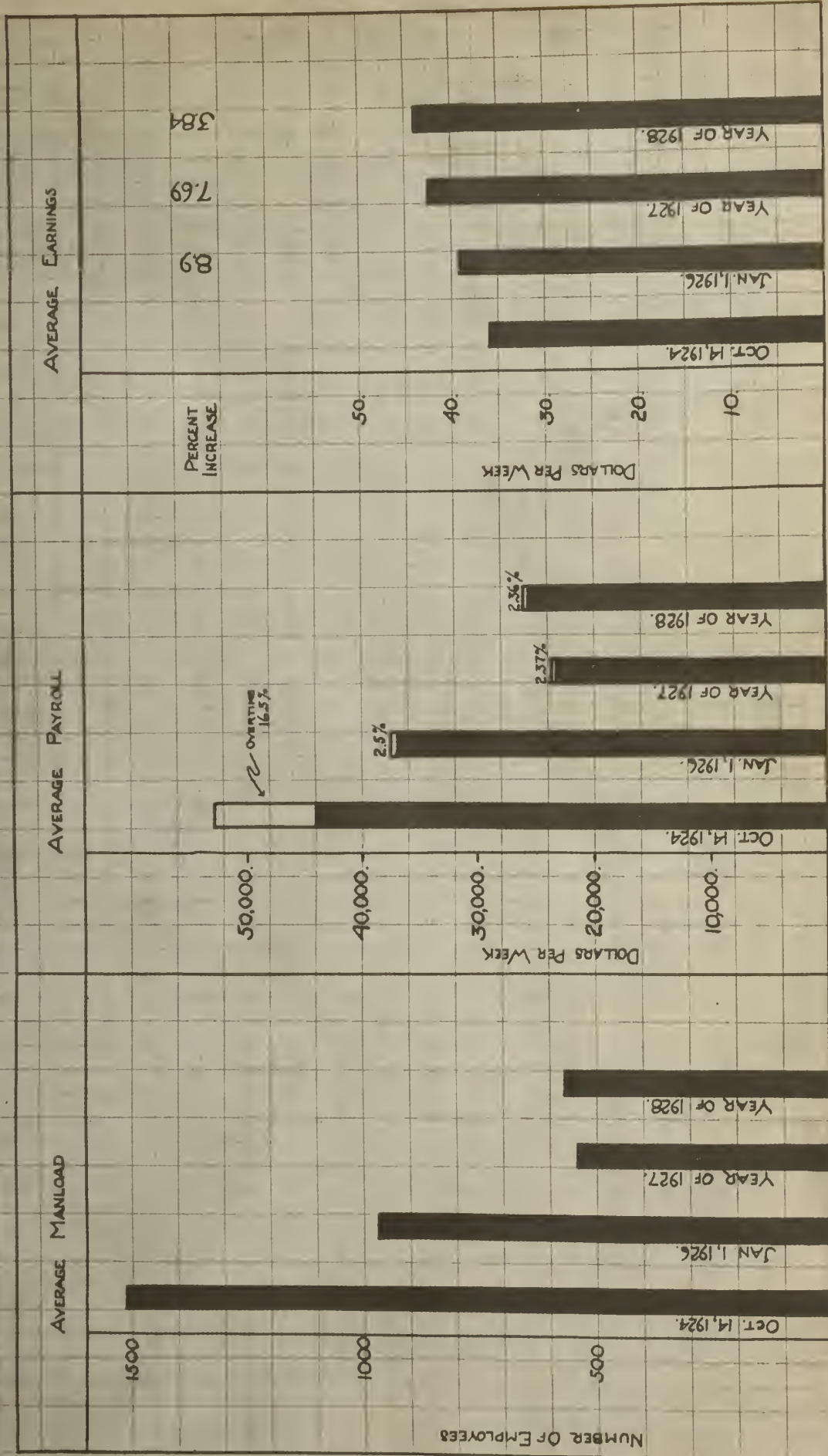


seen by glancing at this chart. It will be found that a total of all classifications, at any given week throughout the year, will aggregate the number of employees designated for that week by the curve at the extreme top. This is true when Local Administration is omitted, Local Administration being in itself a total of all curves below it on the chart. This chart is self-explanatory except for one item. Some explanation should be given of Monthly employees. At a certain stage in salary progress, employees are placed on a monthly rather than weekly payroll. Upon examination of the Engineers' curve we notice a drop at certain points, and likewise we find declines along the curve of the Supervising Foremen. These are occasioned by the transfer of these men from their respective payrolls to the monthly roll. Consequently the Monthly payroll curve shows an increase in men, slowly but consistently.

Another angle of the payroll of interest to the executive is the comparative yearly conditions. In the chart constructed for this study which appears on page 46 we have a four-year comparative view of total payrolls. Incidentally two other items have been portrayed in this graph to show the manload and average earnings in comparative bar charts for the same four years. Although manload will be discussed presently, it will not be portrayed in the bar-comparable

Prepared By: P.C.D.

COMPARATIVE MANLOAD, PAYROLL AND AVERAGE EARNINGS C.O. EQUIP. INST. DEPT.



form in which we picture it here. It appears from this bar chart that a considerable reduction in force was experienced during the years of 1924, '25, '26, and '27 and that in 1928 a slight increase occurred.

True to form the average payroll, as shown in the next section of the chart, followed suit, so to speak. Is it not clear that a very definite picture is provided by a chart like this? How much of the executive's time and energy is used in perusing such concise and definite information? Incidentally we might take notice of the improvement in overtime control as pictured in the center group.

In the third section of this chart we find the comparison of average earnings for each of these years. Just as these figures have increased from month to month within the year, so have they increased at a normal rate from year to year.

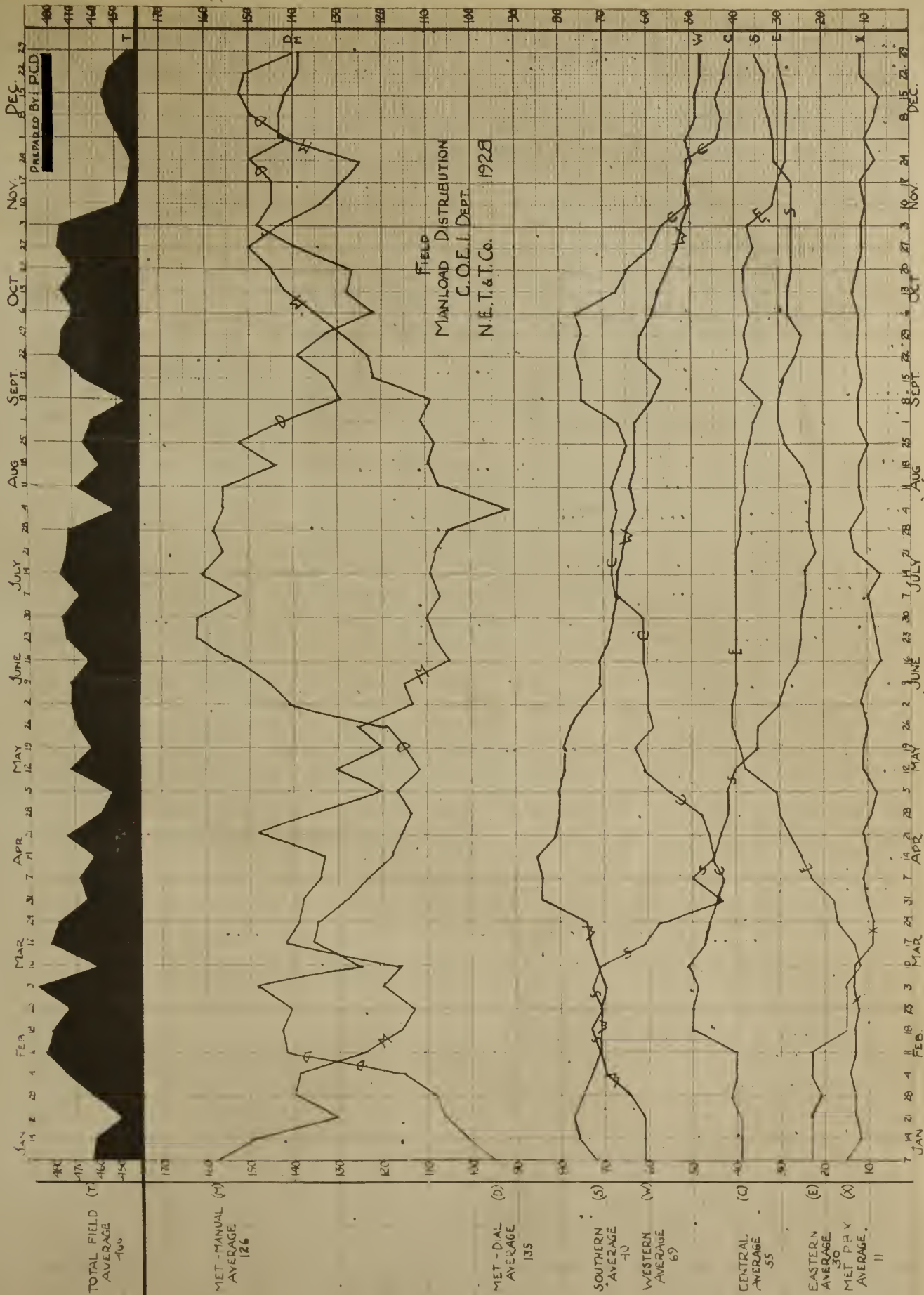
Manload

The preceding pages have by no means given a complete variety of the many phases of payroll analysis. The primary purpose, however, has been to exemplify the possibilities of statistical charts, to some degree, in providing the executive with necessary data in concise and understandable form. It is not intended to attempt to exhaust all of the possibilities in any of the classifications of functions to follow in succeeding pages. Time and space would not permit any such elaboration

here, even if the writer had the capabilities.

It is on these grounds that we should feel justified in passing from the payroll studies to another angle of organization analysis - the manload. While the manload is nothing more than the man-power represented in the payroll, it is a distinctly independent factor when taken out and viewed as a thing apart, in the problems of organization supervision. This point of view is, of necessity, the one we must assume in dealing with manload problems. At this time we will concern ourselves with only such manload studies as will represent the collective man-power as pertaining to the organization. Later studies of man-hours and man-weeks will probably appear under the classification "Labor Studies".

One of the first and most natural requirements in manload data by the executive is that of size and distribution. The size and distribution of the force plays a very important part in production, affecting at once the product and the personnel. Graphic pictures of this angle in organization studies would serve multiple purposes in the supervision of any large and territorially scattered force. The chart on page 49 has been prepared to show the manload distribution, exclusive of staff. A picture of this kind not only gives the executive the general trend from week to week, but also shows the component divisions in that manner. The extreme upper section of



the chart gives the general trend and fluctuations, throughout the year, of the total manload, and provides a good spot picture of peaks and remissions of industry. The several curves below denote the performance of the divisions severally. Regardless of how these individual division trends run, they should, at any given week, sum up to a total manload figure equaling the figure denoted at that week by the total curve at the top of the chart. It should be explained here, perhaps, that the men who are remotely the basic material for this study, are interchangeable and as the work requires, are transferred from one division to another. For this reason the division curves are apt to be very uncertain in their relative positions to one another. Perhaps the reader will be able to look at this picture in an entirely abstract way, forgetting for the moment the symbolic intent of the picture. If this is possible and the reader can imagine this a submarine view of several cables weaving and crossing momentarily at the will of the currents, a good idea can be had of the manner in which these division curves might change. While they do not change so suddenly and so often as the imaginary cables would, they do change in the same manner and by a somewhat similar current - labor supply and demand.

To facilitate the discernment of division curves

throughout the year, the initial letter of the particular division has been placed on the curve near every point of contact with foreign curves. This aids the reader in following a particular division after it has crossed another. It also affords a quicker spot check at any given week or month. It will also be noted that the average weekly manload for the department and for each component division is shown along the left-hand margin, for purposes of comparison.

To the person outside of the particular department for which this chart was produced, it is a hollow picture of man-weeks, perhaps, and then, only because it is labeled as such. To the executive for whom it was drawn, however, it is definitely a manifold of significance. He is also perusing allied reports, complaints, and programs that need only to be coupled with something like this to give a complete story and solution of his problem. Nevertheless, its value to the executive should be manifest, if one takes the trouble to consider the vital facts portrayed in such a chart.

Not to dwell on the details in preparation of the data for this study, but merely as a means of demonstrating the simplicity of tabulation for such a study, the supporting figures are given below in Table A. The initial step in the preparation of these data, is the recording of the reported

manload figure, as received from each Division Chief Clerk weekly. These figures may be carried in tabular form until a year's performance is recorded, or they may be plotted on the chart from week to week until the end of the year, when the curve will have been completed. It is not necessary, nor is it advisable, in view of the limited space available, to show more than two-months' figures in this table. Consequently, only enough is shown here to demonstrate the form used statistically.

Table A

Weekly Manload Distribution by Division - 1928

		<u>January</u>				<u>February</u>		
	7	14	21	28	4	11	18	25
Met.Div.(Man.)	158	149	130	140	139	124	116	113
Met.Div.(PBX)	15	12	13	13	14	13	13	12
Met.Div.(Dial)	95	101	106	108	116	142	143	141
Central Div.	39	39	39	41	40	40	50	50
Eastern Div.	23	23	23	21	23	23	15	15
Western Div.	61	61	61	64	70	71	71	71
Southern Div.	72	76	77	75	73	71	73	71
Total Men	463	461	449	462	475	484	481	473

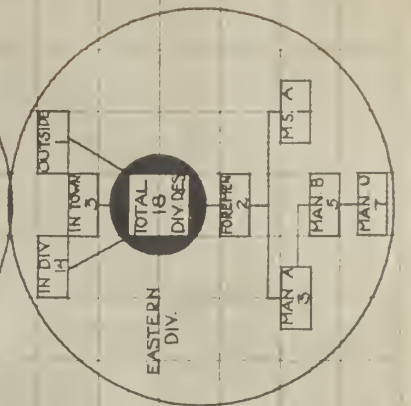
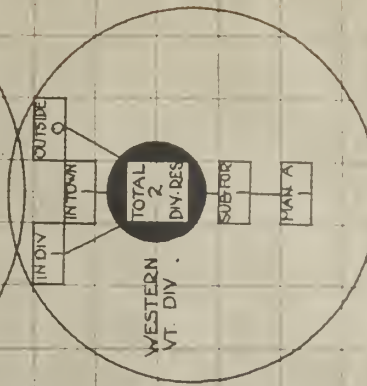
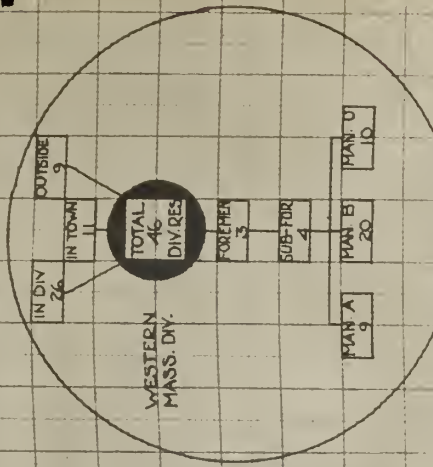
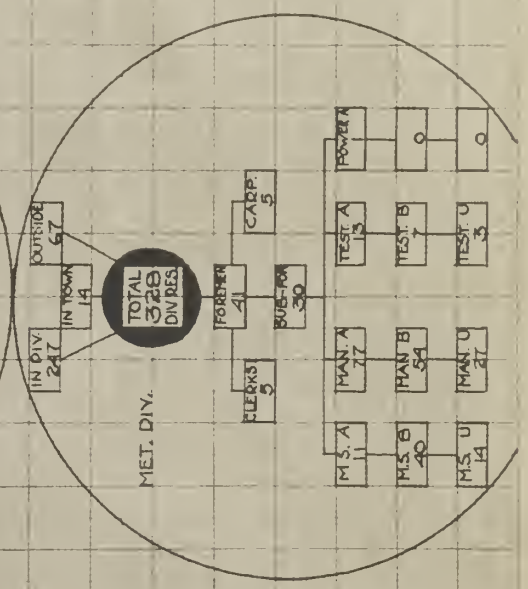
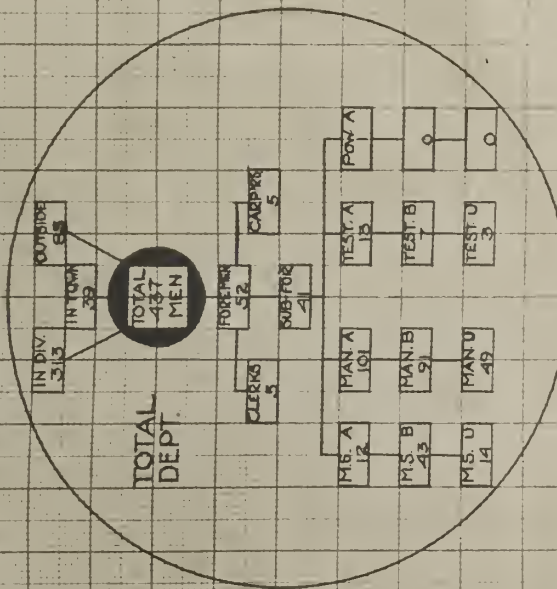
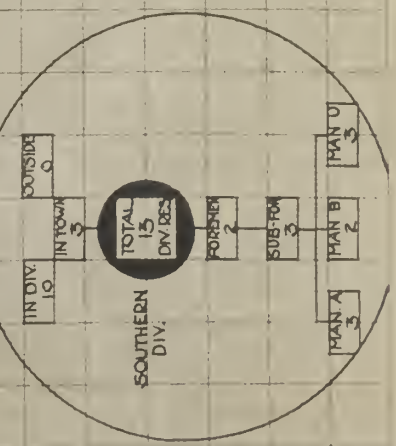
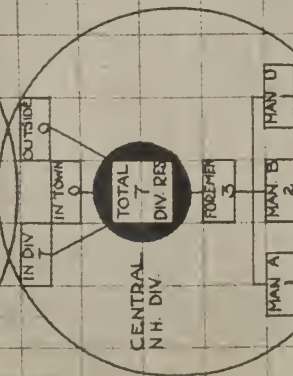
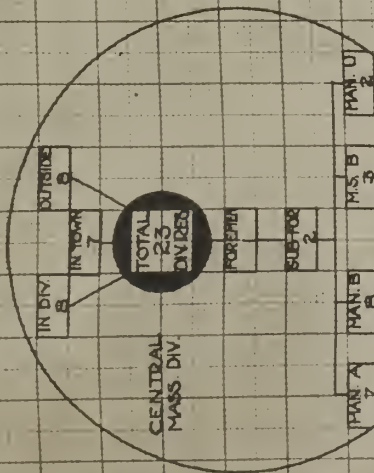
It will have been observed that, in the previous study, no classifications of rank have been considered, but that the manload has been observed as man-power and man-power alone. Because of the constant changes of men from job to job, it would avail us little to produce a study on the rating classification of installers as found in any given area. The presence of the

variously rated men is governed by the size and needs of the particular project. Perhaps it would be advisable here, before presenting the next chart to explain that the classification of installers consists of the following ratings: Foremen, sub-foremen, grade "A" men, "B" men, and "U" or unrated men.

Although the knowledge of existing personnel at work in the divisions is inconsequential, the calibre of the personnel indigenous to the particular divisions is of real value to the executive, in his attempt to allocate men advantageously. Considerable cost is incurred in sending men out of their own divisions and in a great many cases board must be paid in addition to the traveling costs. Naturally, some solution should be sought whereby operating costs might be cut. If a study could be produced to provide the executive with data showing the resident manload by ratings, some tangible means of approach to the problem will have been provided. At the time this survey is being initiated men who live in one division are working in some other distant division and board, traveling, and other voucher expenses are being charged to the department. To cite a specific example, we might have a sub-foreman, who lives in the Central Division, working in the Western Division, while some other sub-foreman is working in the first man's home division and owning a home perhaps in the Eastern Division. In correcting such a condition

RESIDENTIAL CLASSIFICATION

C.O.E.I. DEPT. - APRIL 1929



it would be quite a task for the executive to delve into lists of names and addresses in order to obtain a picture of conditions. For the purpose of portraying this "birds-eye" picture to the supervisor needing it, the chart shown on page 54 has been constructed.

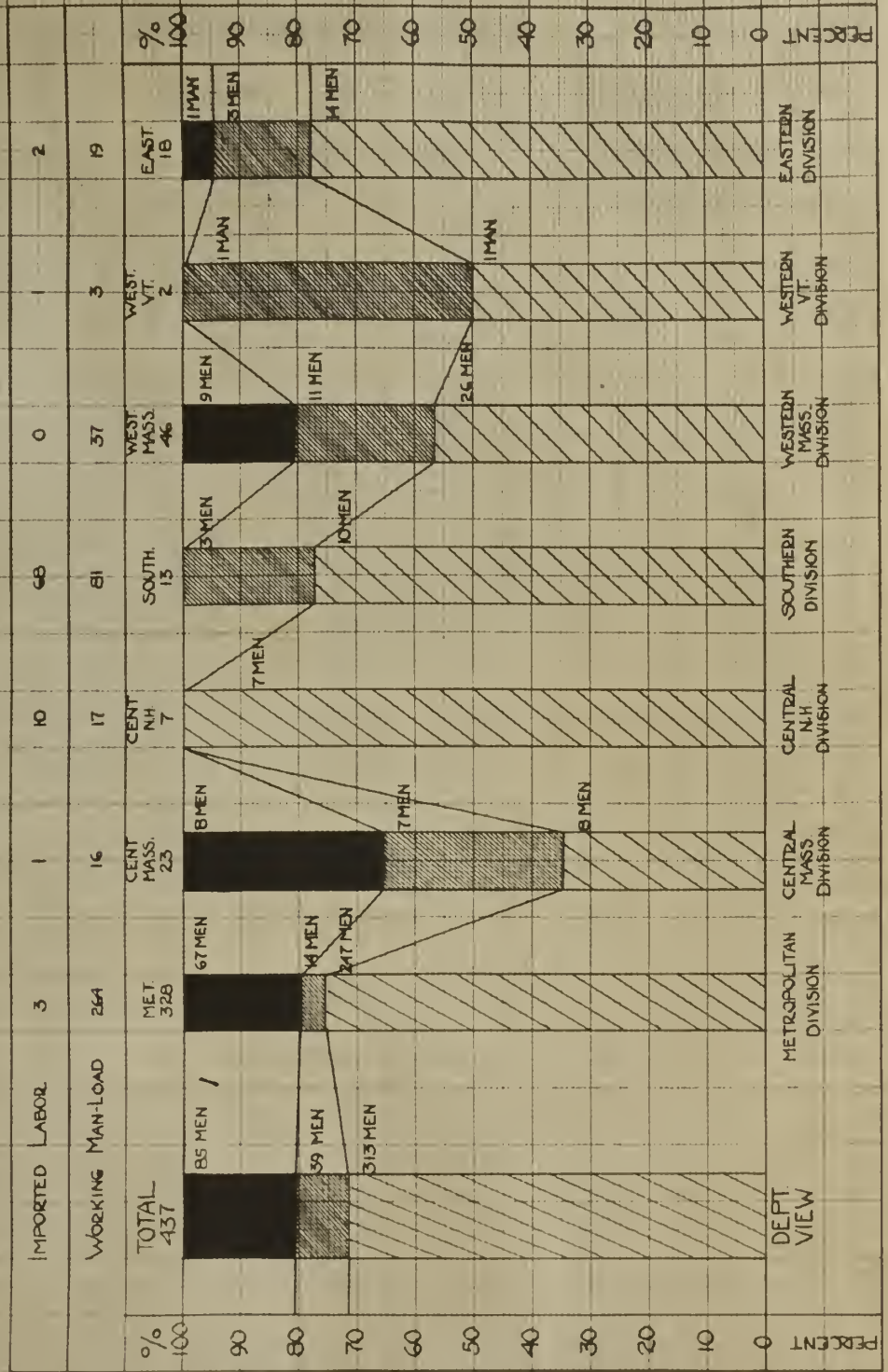
In the residential classification chart we have practically given a group of miniature organization charts, one for each division. Not only have the number of employees, resident there, been given, but a "break-down" of this total has been made to show the type of men represented. Further research has been made in connection with this study to determine and provide the number of these native men now employed in their particular home division as well as the number working elsewhere. A still finer analysis of conditions has been made here in showing what proportion of the total number are employed in their own home towns. An ideal condition would prevail, of course, if all of the men could be assigned to their home towns. This, however, cannot be rationally hoped for in view of the demands of the work, but the nearer the management can bring things to such a "Utopia", the better conditions will be for the company and man alike.

An interesting and comprehensive view of the organization from this angle is pictured in the chart on page 56. To the person unaccustomed to reading graphical charts, this will probably be somewhat confusing at first. When its manifold

RESIDENT LABOR DISTRIBUTION BY DIVISION

COE1. DEPT.
APRIL 1929.

WORKING OUTSIDE THEIR DIVISION
IN THEIR HOME TOWN
IN THEIR OWN DIVISION BUT OUT OF HOME TOWN



provisions become manifest to the reader, however, it will be conceded that the complete picture of a very complex problem is portrayed here in condensed, and yet, adequately informative style. Furthermore, this chart should be self-explanatory, if the reader will take the trouble to view it from all angles. The executive, confronted with the problem of labor distribution, will find in this study all of the causes and effects concerned, and should be able to visualize the conditions of the field organization, without leaving his desk.

Perhaps the enumeration of some of the factors of significance is appropriate here to bring the reader around to the interested executive's viewpoint. It will be seen that the department as a whole, as well as each of the divisions separately, has been proportioned off on a percentage basis to show the degree to which native employees are assigned to their home towns or divisions. In addition to this scale, two other features are provided, affording on sight a condensed analysis of the problem we assume is confronting the executive - the problem of uncovering prevailing conditions causing excessive travel and board expense.

Let us analyze a few of these divisions separately as a means of showing concretely what was originally a surmise only, but which, in view of the facts brought out in this chart,

now proves to be a prevailing delinquency. The first divisional bar on the left, which happens to be the Metropolitan Division, shows a residential manload of 328 men, 261 of whom are employed within their own division. It will be noted that this particular division calls for a working manload of 264 men. As the division needed 264 workers and had only 261 employed there, it was necessary to import the additional three men required from some other division. This was done as is shown by the column marked "Imported Labor", and yet, 67 men who are residents of that division have been transferred to other divisions. We now show three so-called "foreign" men imported and 67 native men transferred elsewhere. Here is a case where three of the 67 men sent out of the division could have been employed in their own division obviating the necessity of bringing in the foreign three.

A larger, but more justifiable, case of importation is to be found in the Southern Division where 68 men have been brought in from outside divisions. However, in this case there are 81 men needed and the division has only 13 native men, all of whom are still being utilized in their own division. It should also be interesting to note the condition disclosed in the Western Massachusetts Division which is next to the Southern in the chart. It so happens that this division

produces 46 men but has a call for only 37, and therefore, must send 9 men elsewhere. There are no outsiders imported there.

In this connection there is another study that should prove of real value in the efficient distribution of manload. The chart on page 60 gives a different view of the situation, showing absolute comparisons of the actual labor employed and the resident manload, in each division. This picture serves to show what divisions have surplus native man-power and on the other hand, those deficient in that respect. Furthermore, a dissection of the standing resident manload has been made to provide the component classifications of the personnel. Incidentally, this chart also shows the location of work by percentages, as well as the resident labor distribution, and makes possible a direct and absolute comparison of the two factors - a view hardly possible by the use of masses of figures.

The aim in presenting these manload charts, as well as all other charts in this and succeeding chapters, is to demonstrate the value of such focal pictures. Thus far, our discussion and research in manload has only been concerned with the distribution phase. In this connection we have selected a problem typical of those confronting the executive, from time to time, in the performance of his duties as supervisor.

1928

NOTE

Resident M.L. and Dec. 31st
Actual Labor for entire year

[illegible]

Let it not be assumed, however, that this is the only angle from which manload can be viewed. There are numerous other presentations possible in studies of this item of the organization.

The collection and tabulation of facts preparatory to the charting of these studies is, by no means, a difficult or magic stunt. To the statistician adequately familiar with the general functioning of the organization, and possessing little more than a rudimentary knowledge of the application and presentation of statistics, it is merely a routine task, worthy only of the attention of capable clerks under his direction.

Personnel

There is still another group of studies worthy of consideration in connection with this chapter on organization analyses. The personnel features of the organization while drawn from practically the same primary data and personalities from which the manload facts were, are peculiarly different in complexion, when we refer to them as personnel items. At least, the connotation conveyed by this term creates a distinction in one's mind between that item and the item suggested by the former term, manload. There is truly a difference and particularly in the case of the references made in this thesis

because of the fact that the studies with which we are concerned here, on personnel, will affect not only the field force, but the staff employees as well.

To introduce the subject of personnel studies properly, it is probably advisable to present, at first, a picture of the entire personnel organization in composite form. Such a picture will be found in Table B, on page 63, where the entire personnel organization has been classified, and where the logically desired statistics pertaining to these various groups have been condensed to a concise and informative style. As this table is self-explanatory, we will forego any further comments, and pass on to some of the specific personnel items of interest to the executive.

During our attendance on personnel matters, it is only natural that we consider at least one educational study. Because of the needs of the service in delegation of authority and responsibility, the executive must know the educational background and potential capacity of the individual, as well as that of the personnel as a whole. Consequently, a study of the educational attainments is in order. A study of this kind necessarily requires considerable detail work in view of the fact that it is made up of individual records. The method employed in tabulating the data for this study is very

Table B

Composite Personnel Study

	Code	Total	Age.		Aver.	Years Serv.			Salary		
			Young	Old		Min.	Max.	Aver.	Min.	Max.	Aver.
						Serv.	Serv.	Serv.	Sal.	Sal.	Sal.
Assts.to Oper. Off'l. and Supts.	220	7	36	50	42	15	29	21	81	104	88
Engineers	400	30	25	54	35	6	39	13 $\frac{3}{4}$	42	96	60
Accountants	600	1	40	40	40	16	16	16	62	62	62
Cashiers	710	1	29	29	29	7	7	7	42	42	42
Sup.Clks.(Office)	721	* 6	30	56	42 $\frac{1}{2}$	15	31	22	*28	50	43*1F 5M
Sup.Clks.(Field)	721	4	34	60	41 $\frac{1}{2}$	8	18	15	42	42	42
Clerks (Office)	731 734	*25 (* 18 female	19	40	28	1/2	16	6	16.50	39.	25.62
					7	Male)					
Clerks (Field)	734	4	29	69	47 $\frac{1}{2}$	6	30	17	34.50	40	37
Stenographers	740	* 2 (* 2 Female)	22	24	23	5	7	6	25	26	25.50
Messengers	750	1	18	18	18	1	1	1	14	14	14
Supv.of Inst. Supv. Foremen	1301	20	35	58	46	12	34	23 $\frac{1}{2}$	56	77	65
Foremen	1303 1410	48	27	59	38 $\frac{1}{2}$	7	30	16	51	61	55
Sub-Foremen	1415	45	25	55	36	6	31	12 $\frac{1}{2}$	45	52	49
Manual Inst.	1420	243	22	59	33	3	32	9	33	49	42
Mach.Sw.Inst.	1421	77	21	49	31	1	13	7 $\frac{1}{2}$	27	49	41
Testers	1423	27	25	42	31	5	12	7	36	49	42
S.S.Foremen	1510	1	37	37	37	17	17	17	58	58	58
S.S.Inst.	1520	5	34	50	40 $\frac{1}{2}$	7	23	15 $\frac{1}{2}$	45	48	47
Storekeepers	1761	2	33	40	36	$\frac{1}{2}$	12	20	16	42	44
Carpenters	1770	7	40	68	54	7	34	18 $\frac{1}{2}$	37	48	39
Other Skilled Employees	1790	1	31	31	31	12	12	12	57	57	57
Totals of Dept.		557	18	69	36	1/2	39	13	14	104	46

simple, however, and consists merely of determining the category into which each employee should be placed. In instances of this kind, bar charts are naturally most desirable for absolute comparisons. In the chart on page 65, it will be noted that each group has its several categories. Working from right to left, each sub-division is a step higher, in educational accomplishments, than its preceding, neighboring class, and the entire range of the study runs from a common school training to the Graduate School of a university. The group percentages on the right show the ratios of the different groups.

Little can be added, about this study, that is not apparent to the reader. In addition to its disclosure of the general educational calibre of the department, it affords an absolute comparison, within groups, of finely segregated categories. In fact, this chart makes possible the selection of groups at every step along the educational scale. Proportions of staff employees represented in each group are available, should any information of that sort be desired. To the executive contemplating new policies or reorganizations, an educational view in such ready and comprehensive form is of inestimable value.

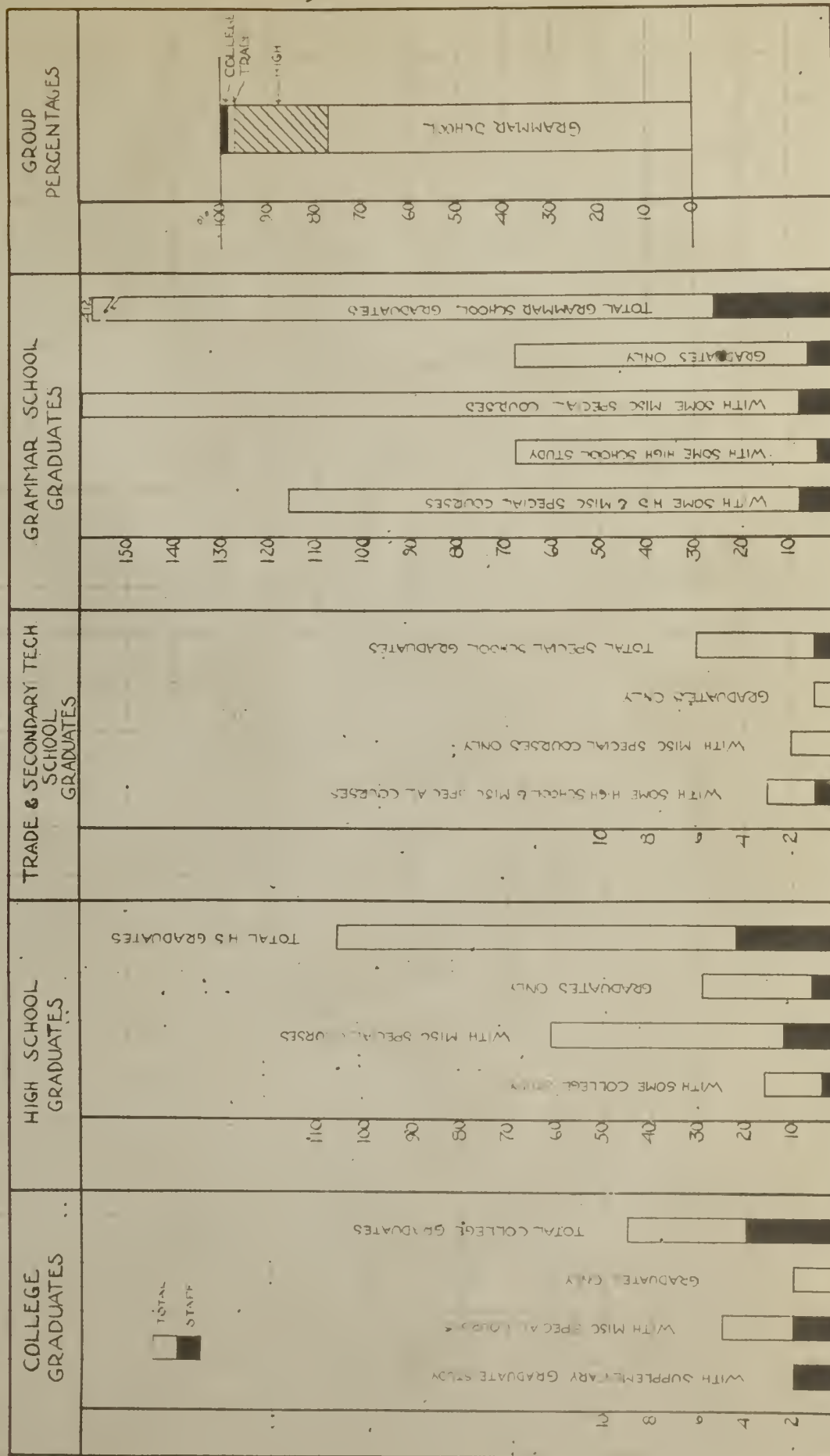
To produce a study on a few more specific items falling under the heading of personnel, we will consider the

EDUCATIONAL CLASSIFICATIONS

C.O.E.I. DEPT. - N.E.T. & T. CO.

JAN 1, 1929

-65-



age and service factors and portray them in the form of a distribution chart. This chart which appears on the next page combines both of these factors, and serves to show the number of employees found at any given service period, as well as the number of employees to be found at given ages. Incidentally the greatest frequencies of ages and service years are readily perceivable.

Along these lines, a salary distribution chart should be appropriate, and in order to prepare for a proposed study of all of these factors, we will introduce the salary picture to the exclusion of further comment on the age and service chart. It is intended to again revive these items in a later study, in which all three factors will be portrayed together in their primary unit relations. Table C providing the supporting figures for the salary distribution chart will be found below. (Only part of this table is shown because to include the entire table would be a useless waste of space. The portion shown will serve adequately to demonstrate the method of tabulation.)

Table C

Frequency Distribution of Salaries

<u>Wkly.</u>	<u>Total</u>	<u>Staff</u>	<u>Wkly.</u>	<u>Total</u>	<u>Staff</u>
\$36.	35	3	\$39.	1	1
36.50	1	0	40.	2	0
37.	2	0	41.	0	0
38.	10	0	41.50	31	0
38.50	5	0	42.	8	2

PERSONNEL VS SERVICE AND AGE C.O.E.I. DEPT.

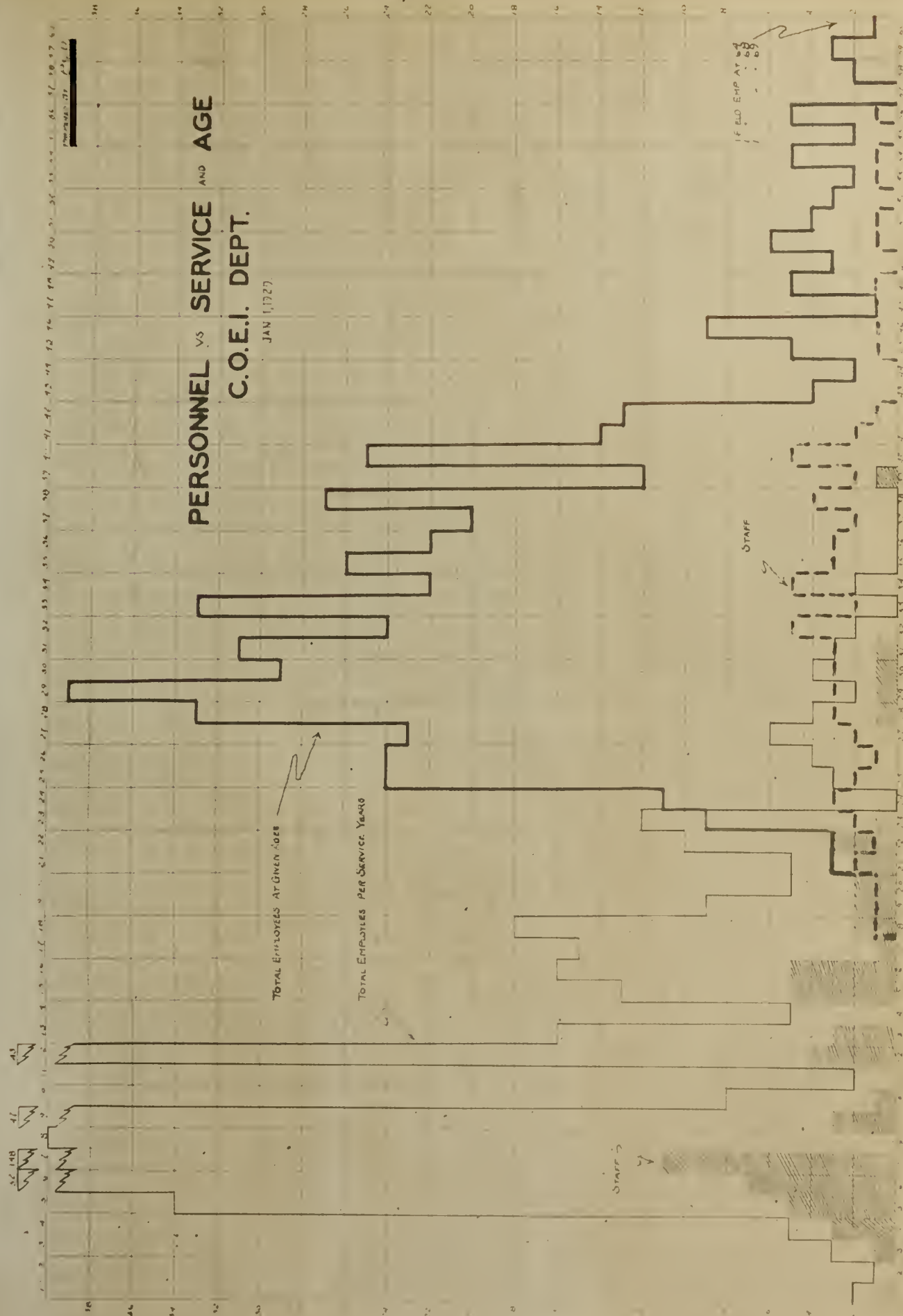
JAN 1, 1927

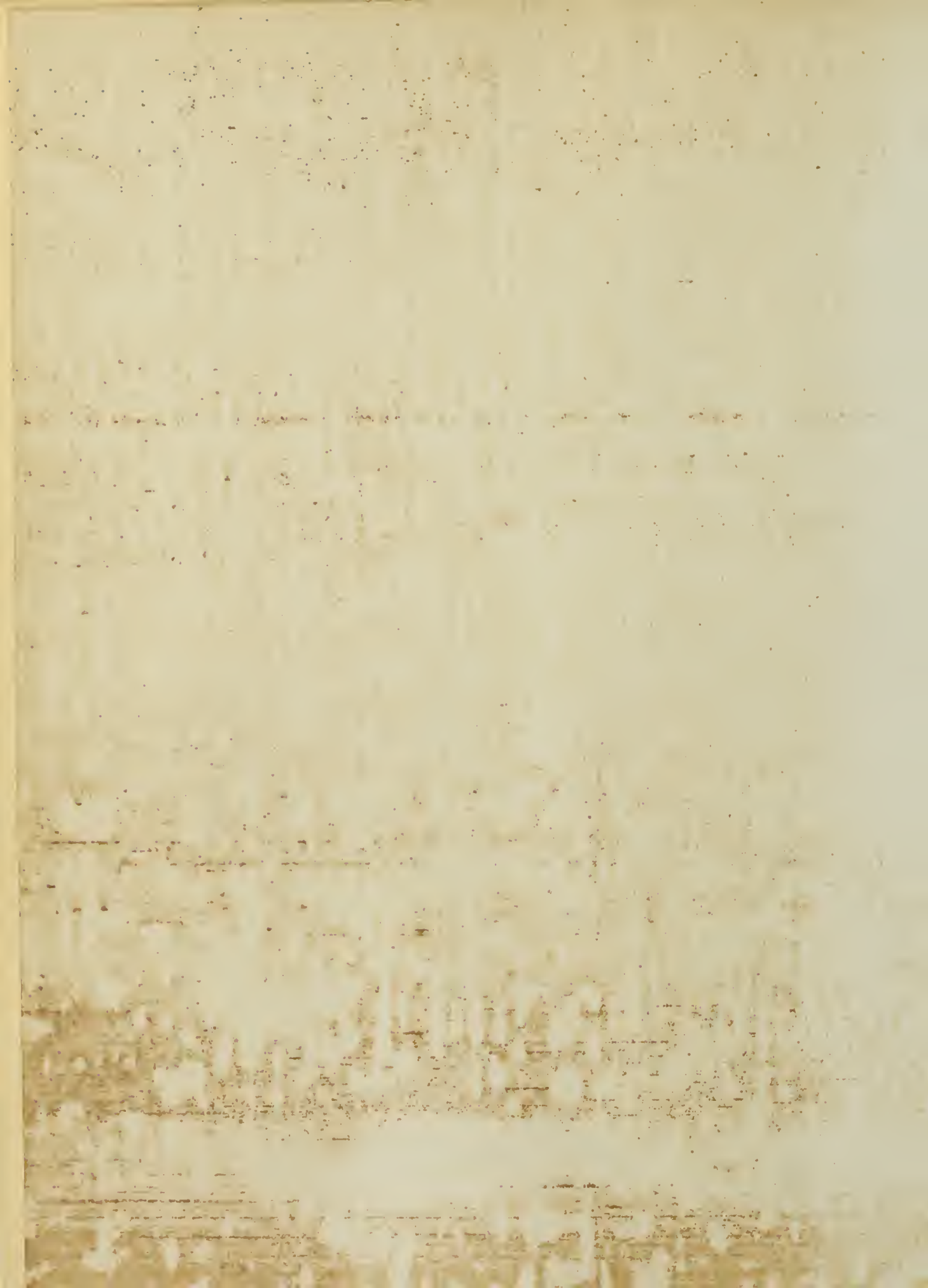
TOTAL EMPLOYEES AT GIVEN AGES

TOTAL EMPLOYEES PER SERVICE YEARS

STAFF

IF EMP AT 60





Due to the nature of this salary study, considerable detail counting was necessary to obtain the data for this table. Because of the constantly changing status of employees throughout the department from a salary standpoint, summarizations of this sort are more preferable as "spot" propositions, rather than as running records. Therefore, at the time of need for these data, it is necessary to completely summarize and tabulate from individual records. Unless some statistical file is maintained on salaries alone, to which can be posted all individual changes as they occur, and which, upon examination, will reveal these appendices, it would be impossible to bring this study up to date without again summarizing the salary items of the entire personnel. As the need for a salary distribution study from this angle is quite an uncommon occurrence, few concerns have the data in the necessary and available statistical form. The executive, then, in the case of need for this information, would encounter no small amount of inconvenience and delay in procuring the desired facts.

Like most other distribution tables, the desired perspective is lost in the even mass of figures, and, therefore, the graphical chart is produced from the tabulated data to show desired comparisons and relations. On page 69 we have pictured this study in chart form, which needs no explanation here. In order to make this picture more complete from a salary standpoint, we have shown here averages for each classification of employees. These averages were not

the first of the two main groups of the world.

The second group is the group of the world.

The third group is the group of the world.

The fourth group is the group of the world.

The fifth group is the group of the world.

The sixth group is the group of the world.

The seventh group is the group of the world.

The eighth group is the group of the world.

The ninth group is the group of the world.

The tenth group is the group of the world.

The eleventh group is the group of the world.

The twelfth group is the group of the world.

The thirteenth group is the group of the world.

The fourteenth group is the group of the world.

The fifteenth group is the group of the world.

The sixteenth group is the group of the world.

The seventeenth group is the group of the world.

The eighteenth group is the group of the world.

The nineteenth group is the group of the world.

The twentieth group is the group of the world.

The twenty-first group is the group of the world.

The twenty-second group is the group of the world.

The twenty-third group is the group of the world.

The twenty-fourth group is the group of the world.

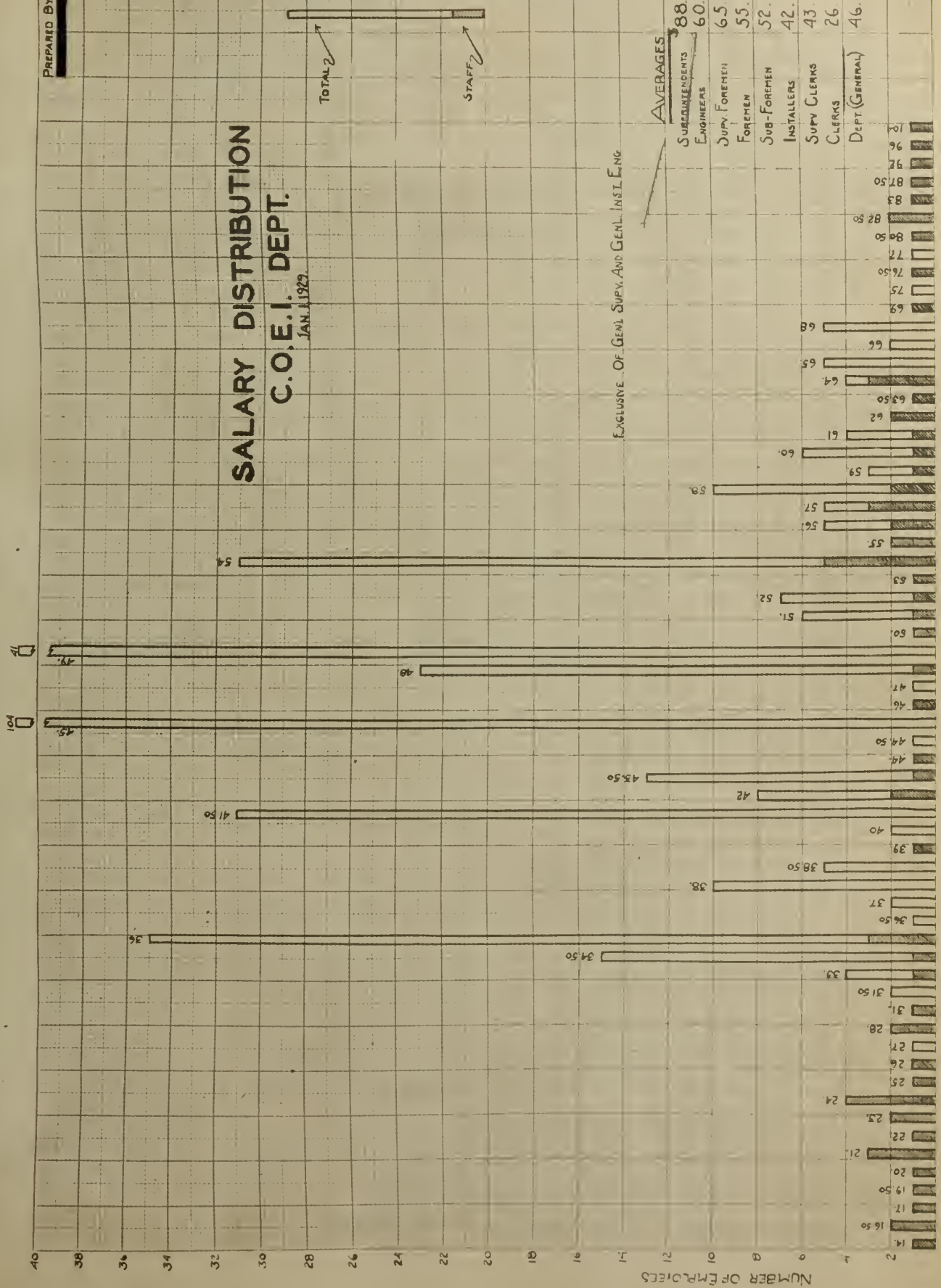
PREPARED BY: PCD

SALARY DISTRIBUTION C.O.E.I. DEPT. JAN. 1927

EXCLUSIVE OF GENL SUPV. AND GENL INST. ENG.

AVERAGES

SUBORDINATES	88
ENGINEERS	60
SUPV. FOREMEN	65
FOREMEN	55
SUB-FOREMEN	52
INSTALLERS	42
SUPV. CLERKS	43
CLERKS	26
DEPT. (GENERAL)	46



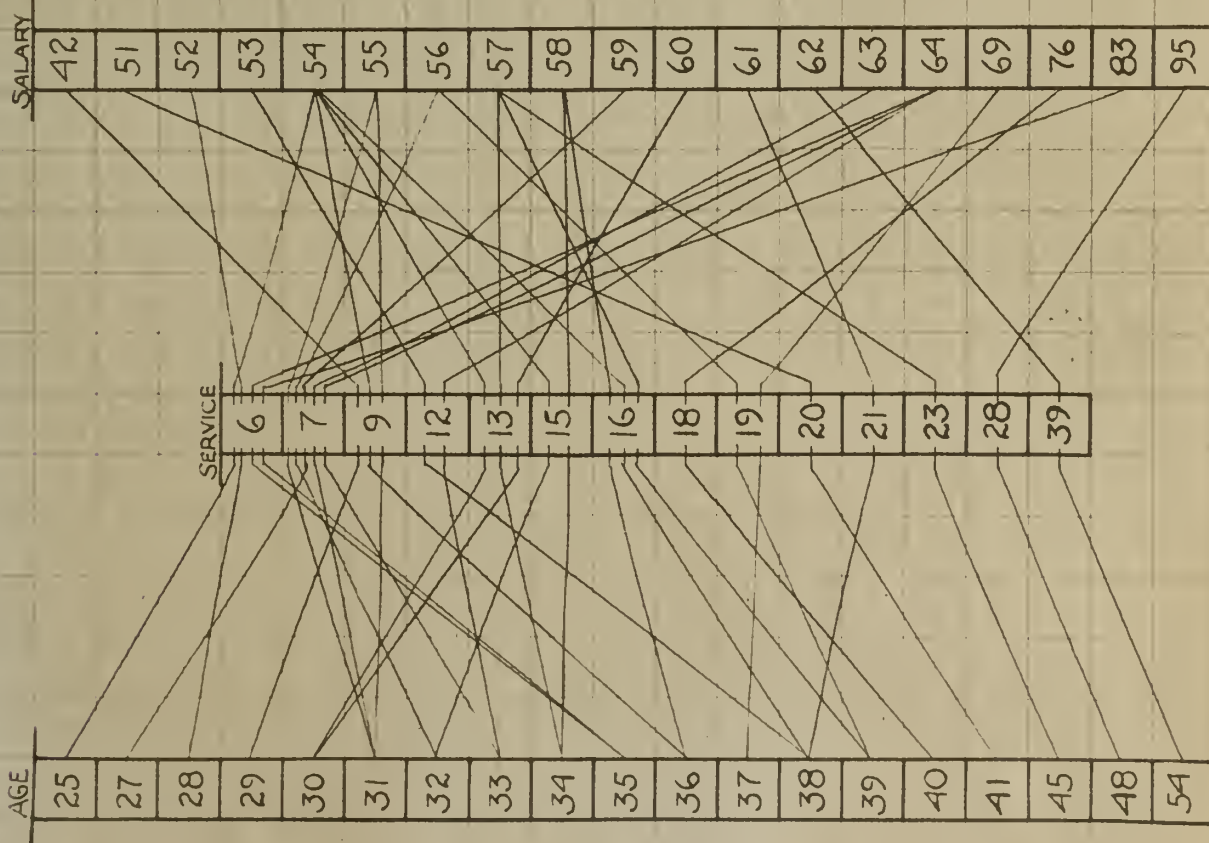
computed from the figures found in the supporting table for this chart, however, but were extracted from Table B found on page 63. It is frequently possible to so transport figures from one study to another when they are related, and very often the same primary data is material for several distinctly multiform uses.

In the age, service, and salary studies just considered, a view from the organization standpoint has been obtained, where they have served to show the composition of the personnel rather than the individual employee's progress or standing. If all three of these factors could be shown together in one chart, and shown in their proper relations to one another, signal facts should be apparent. A single group of employees has been selected from the data found in Table B, and this group has been exemplified in demonstrating how the factors of age, service, and salary can be associated with the particular individual to whom they all apply. This proves to be a very interesting picture as found on page 71.

There are many angles from which this chart can be studied. Any one of the three factors can be used as a base from which to trace the employee through the others. It will be noted that the frequency of any given unit, within any one of the three factors, can be determined by the number of tracers terminating there. The split or analysis of any of the units can also be had by following its tracers to their destination in the other factors. For example, let us take

PREPARED BY: PCD

SALARY
vs.
AGE & SERVICE
C.O. EQUIP.
ENGINEERS
JAN. 1, 1929



the salary unit of fifty-six dollars. This item has two men involved, one of which has seven years service, and the other, nineteen years. To go further still, we find that the man of that salary who has seven years of service, is only thirty-two years of age, while the other, whom we have traced to nineteen years of service, is thirty-nine years of age. This would work just as well, using either of the other factors as the base, depending upon the initial information or interest.

To make this study personal in its disclosures, we need only to place the names or initials of the particular men beside their respective ages. An individual could then be traced through all three factors. His progress could be told at a glance by the angle of his tracer. Naturally, a tracer dropping sharply from a short service record to the higher salaries, would denote a man in advance of the normal rate of progress. Likewise one shooting sharply upward from the long service records to the lower salaries, would belong to a man not progressing very rapidly, or even lagging behind the average of the particular group to which he belongs.

While this manner of portrayal works very well for the different groups, it would be inadvisable as a chart for the entire department because of the magnitude of the whole. The frequencies of the different units would probably be too great for the ready discernment of individual tracers.

Only a few of the many personnel studies possible have been given in this chapter, in order that we might devote the space to the several other management factors contemplated in this thesis. In later pages some of the proposed studies probably border on the personnel phase of interest, but are placed in other categories because of the greater significance they have in that other connection. Some will probably be found under the "miscellaneous" heading also, but only because of their seasonal or emergency nature. It is hoped that enough of these studies have been submitted, however, to demonstrate their value to the management, in controlling personnel problems.

Chapter VII

Cost Studies

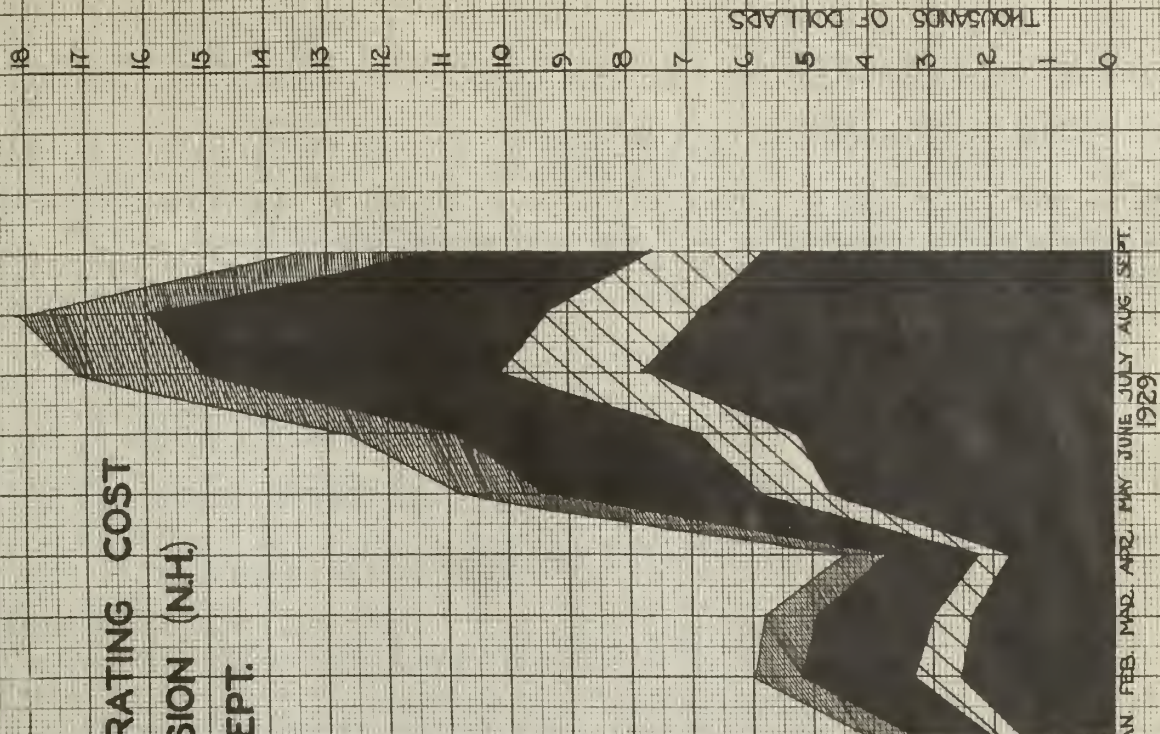
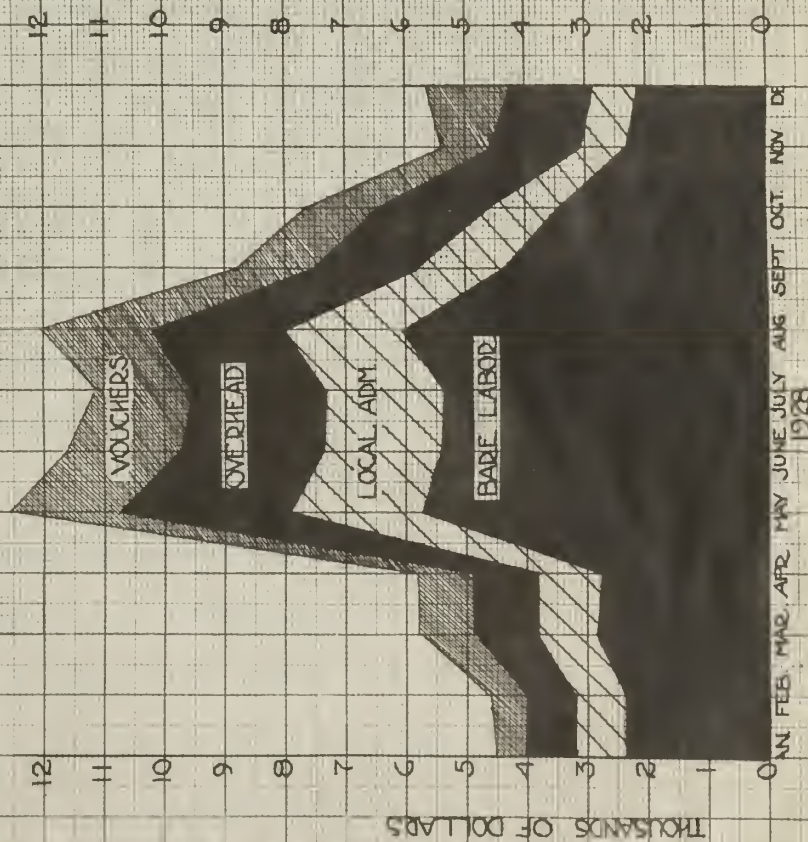
We now come to the consideration of Cost, and, in beginning with general operating costs, we give precedence in our discussion to the parent items first, wherein the indications for the need of further detail studies are very apt to become apparent. Here, as everywhere in our studies, we must anticipate the executive's viewpoint, and govern our statistical production accordingly.

Total Operating Cost

In the analysis of operating costs, our first problem, most naturally, would be one to produce a picture of total trend of the sum of cost factors. In presenting such a picture we might find it possible to show, incidentally, the behavior of each factor curve. When the general trend of costs is known, further information is usually sought to determine the factors constituting the total. Their relative proportions to one another, as well as the proportion of each to the total, are of manifold significance.

Without too much preliminary discourse, we will present a study in operating cost, wherein the various items of expense are portrayed with the resultant total cost. In the chart on the following page will be found four contributing factors to the operating cost. Here we find, not only the trend of expenses, but the proportions occasioned by each of the four items of expense. It is manifest

ANALYSIS OF OPERATING COST CENTRAL DIVISION (NH.) C.O.E.I. DEPT.



folly to expect any operating department to run on bare productive labor alone, but on the other hand, it is hardly expected that overhead and other incidental expenses will come any where near the productive labor figure. In view of this general belief, what is the executive going to think when he looks at this chart, where the amount of the administrative expenses not only equals that of the productive labor figure, but exceeds it?

Accounting records from which this study was made, could not be kept economically in the form necessary to produce a picture, portraying these vital facts. To tabulate the data from which this chart was constructed, it was necessary to rearrange, into statistical form, all of the accounting summaries. Accounting records, as such records go, would provide a very poor field from which the executive could watch expense curve behavior.

Let us examine this chart further and we find that the overhead item has been divided distinctly into three parts, thereby giving a more minute analysis of the cost factors. Here the direct supervision is shown as Local Administration, while the proportion labeled "Overhead" represents the more abstractly general overhead, such as: heat, lighting, rent, etc. Voucher expense has been shown in semi-contrast, in order to provide a separate picture of its occurrence, should such information be desired. A more complete analysis of the voucher item will be made in later pages.

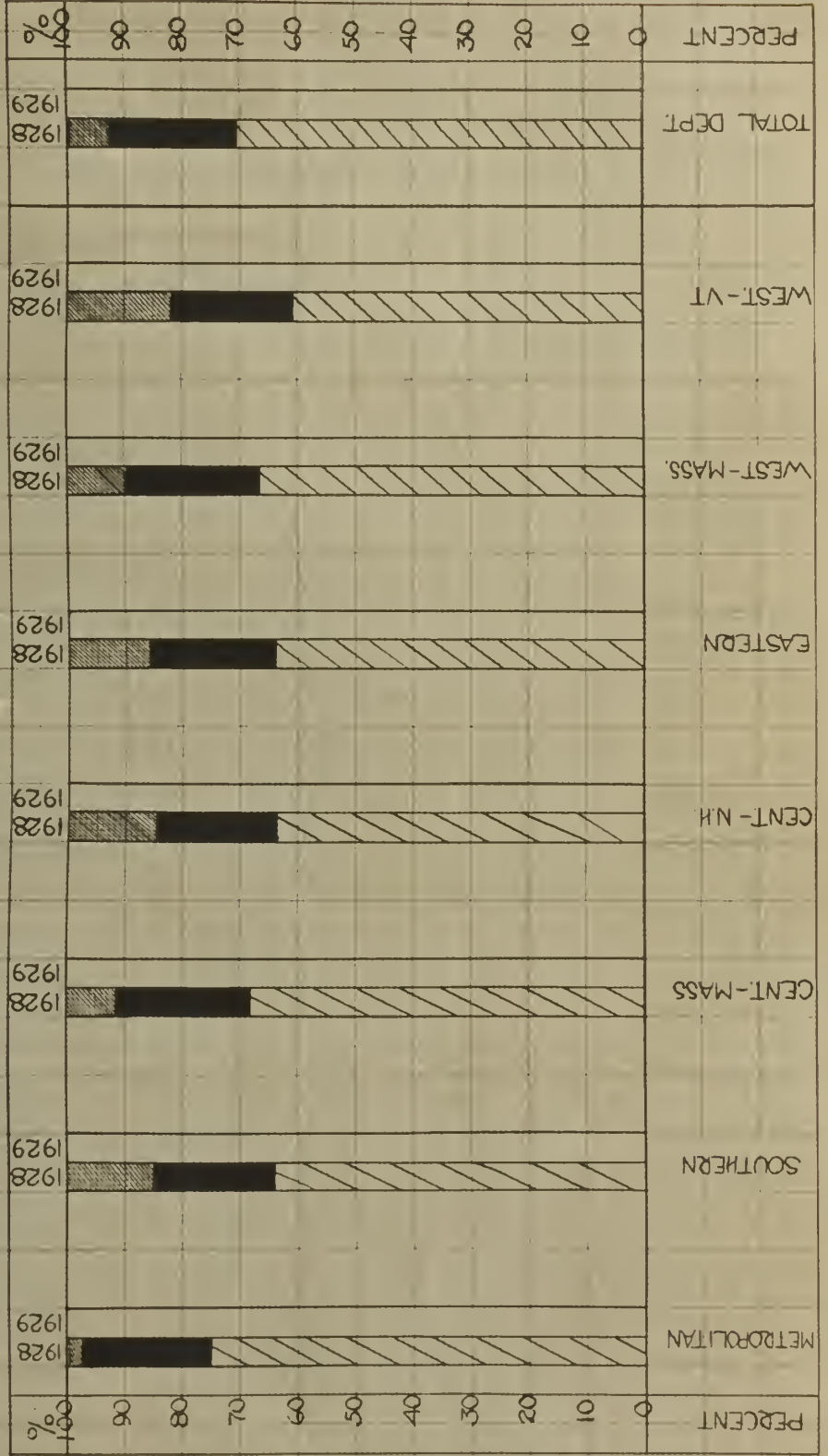
It will have been observed, in glancing at this chart, that an excessive rise has occurred toward the middle of the second year. This is only another significant, and probably somewhat alarming fact brought to the attention of the executive reading the chart. A rise like this could well be foreseen if a progressive curve could be posted from month to month. While this fluctuation is probably abnormal and unprecedented, it is very likely to be justified, and probably occasions no increase in the general operating cost of the department. However, whether or not a corresponding decline is shown in some other division, this abnormal rise is indicative of increased activity in the Central Division. Perhaps if we were to plot the curve for the whole department, we would find a very small degree of fluctuation throughout the entire year. It is, therefore, unwise to jump at conclusions, and assume immediately that unwarranted expenditures are being made. Nevertheless, several disclosures are apparent in this study and the progressive executive is bound to seek an explanation of some of these uncommon conditions.

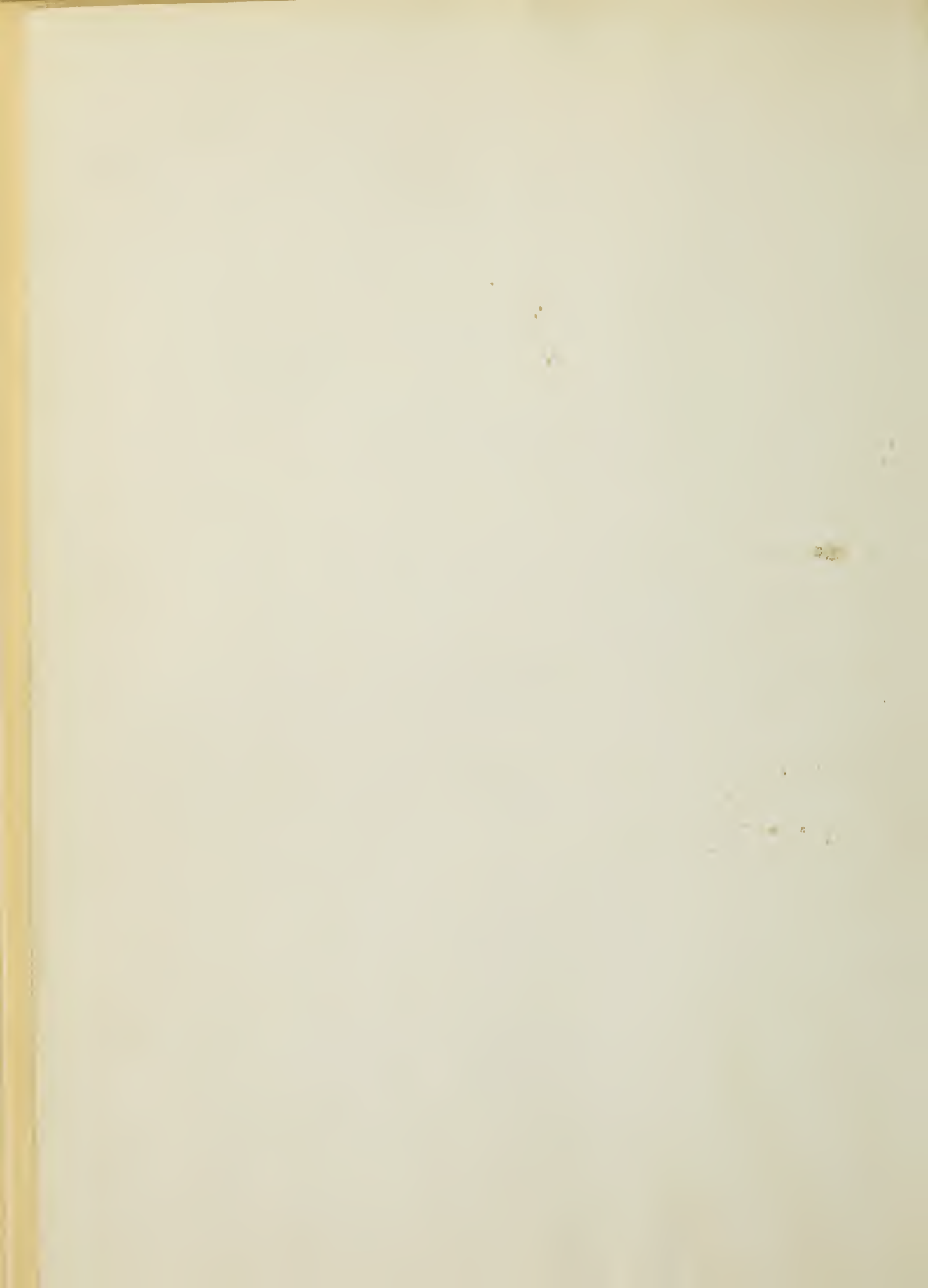
Although we have given a very complete "break-down" of operating costs in this recent chart, we have portrayed it in such a form as would provide the picture of only one division's performance to a chart. A chart has been constructed, as shown on page 78, to show the percentage the major cost factors assume in each division. In the supporting data for this bar-type chart the

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ANALYSIS OF OPERATING COST C.O.E.I. DEPT.

LABOR - OVERTIME - VOUCHER





labor item has not been split, and in this instance Local Administration is considered a labor charge. Any further explanation of this chart is unnecessary, except that we may note the fact that provisions have been made in each division for the drafting of another year's performance for comparison purposes.

Before passing from the general and overall view of operating cost, it might be appropriate, at this time, to introduce a composite study in tabular form, providing the Department Head with a condensed view of all factors of cost. Perhaps, in this connection, it will be possible to provide along with the actual current expenses, comparable figures of other periods. It might even be possible to provide the limits of a normal range. In Table D, below, these facts are presented, as a monthly analysis.

Table D

Analysis of Costs Monthly

	1928 Aver. Amt.	%	1929 This Month	1929 Last Month	% of Diff- erences	1929 High Mo.	1929 Low Mo.	1929 Aver.	* % Diff
Bare Labor	72937.49.62		76202.	81197.	-0.94	84100.	61700.	74642.	+ 2.3
Lost Time	14701.10.04		17420.	12205.	+0.7	27322.	10042.	15214.	+ 3.5
Local Adm.	23399.15.92		19188.	20832.	-0.93	21388.	19020.	20421.	-12.7
Overhead	35572.24.42		50502.	50161.	+0.99	52303.	38995.	46183.	+29.9
Total Cost	146609. 100.		163312.	164395.	-0.99	164395.	146101.	156555	+ 6.8

* Percent of 1929 average, above or below average for 1928.

Complex as it may seem at first, this table is actually

a simplified condensation of facts procurable only by perusing figures of several month's performance. In the form presented here, concise material is afforded the interested executive to aid in the control of operating costs.

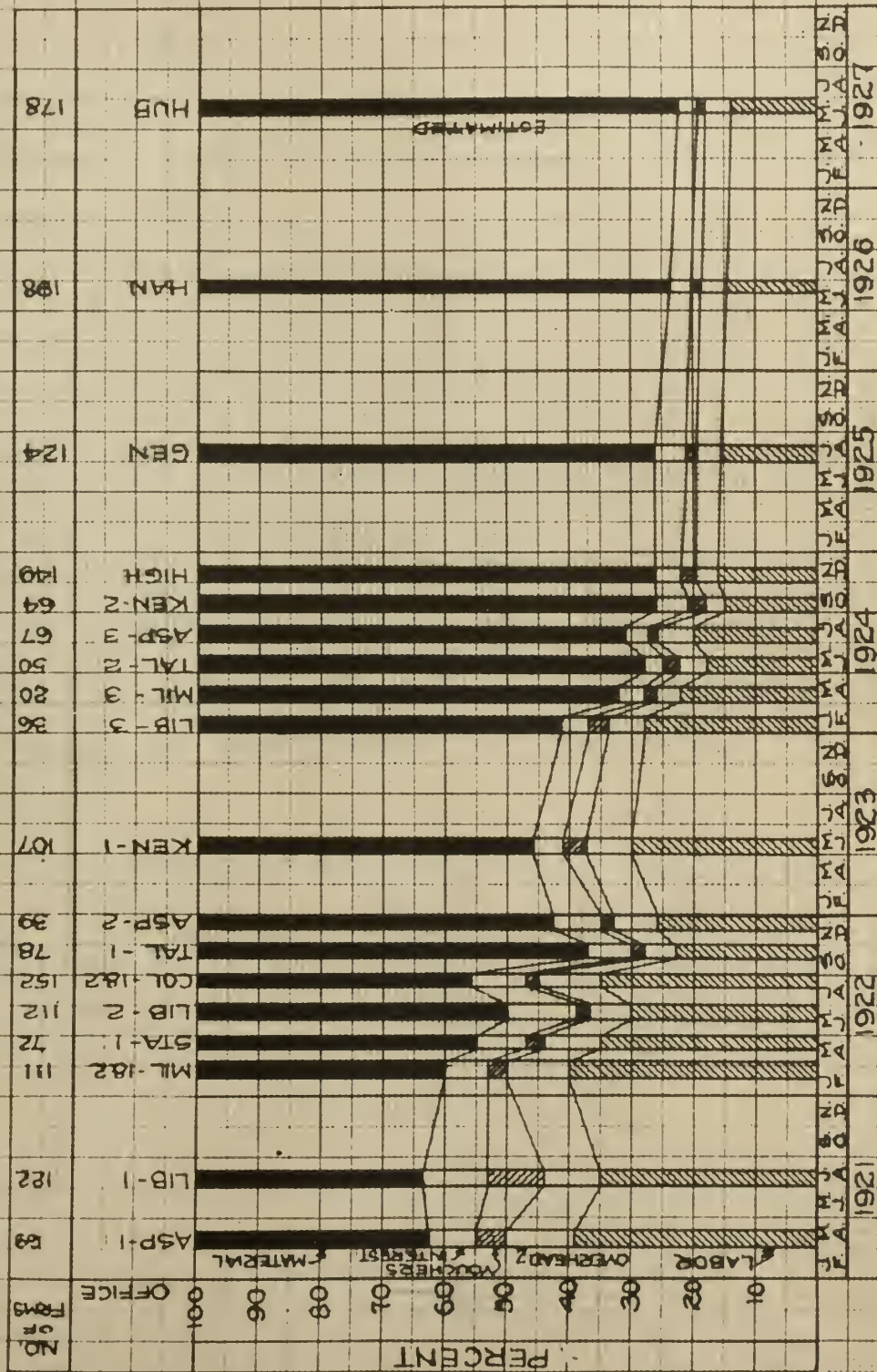
Specific Job Costs

Along the lines of operating costs, but in a more specific application, a study of comparative costs of like projects should be of signal value to the supervisor. In previous studies, our analyses of operating costs have dealt with the dissection of the total cost figure from the divisional standpoint. Let us now consider the matter from the standpoint of individual projects, and attempt to show the relative performances of these jobs of like nature.

The chart on the following page represents a study made on several similar projects, wherein we show the component cost factors on a percentage basis, within the bounds of the particular project to which they apply. An added feature has been introduced here, however, to permit the plotting of true proportions. This new item, it will be noted, is material, which carries with it certain interest charges, shown also. A two-fold purpose is served in using this item, as will be seen presently. Because of the use of percentages instead of absolute quantities, no means of knowing the comparative sizes of these projects is provided. Therefore, it is fitting that we insert some feature denotative of size. This needed index is obtained in the designation of the number of frames installed.

6

RELATION OF COMPARATIVE COSTS PANEL MACHINE SWITCHING



The magnitude of the project can be judged by the number of frames required.

Not only are the relative proportions of cost factors shown in this chart, but a trend is incidentally resultant, which, by the way, denotes an increase in labor efficiency. As we progress through the months and years, it will be noted that less labor, with its accompanying overhead costs, is used to install the equipment. This is apparent by the increase in material proportions and corresponding decrease in operating costs, toward the later projects. It stands to reason that the more equipment a given dollar of labor will install, the greater the efficiency of labor. To dwell any longer on this subject would probably be to trespass upon the labor efficiency studies, with which we are to deal presently.

Labor Costs

In any type of business where labor is necessary on a large scale in operation or attendance, studies are bound to be required by the progressive executive. In fact, labor studies are of paramount importance wherever labor plays a prominent part in the production. There should be no difficulties encountered in procuring the data for such studies if accounting summaries are made.

Labor might be viewed from many different angles.

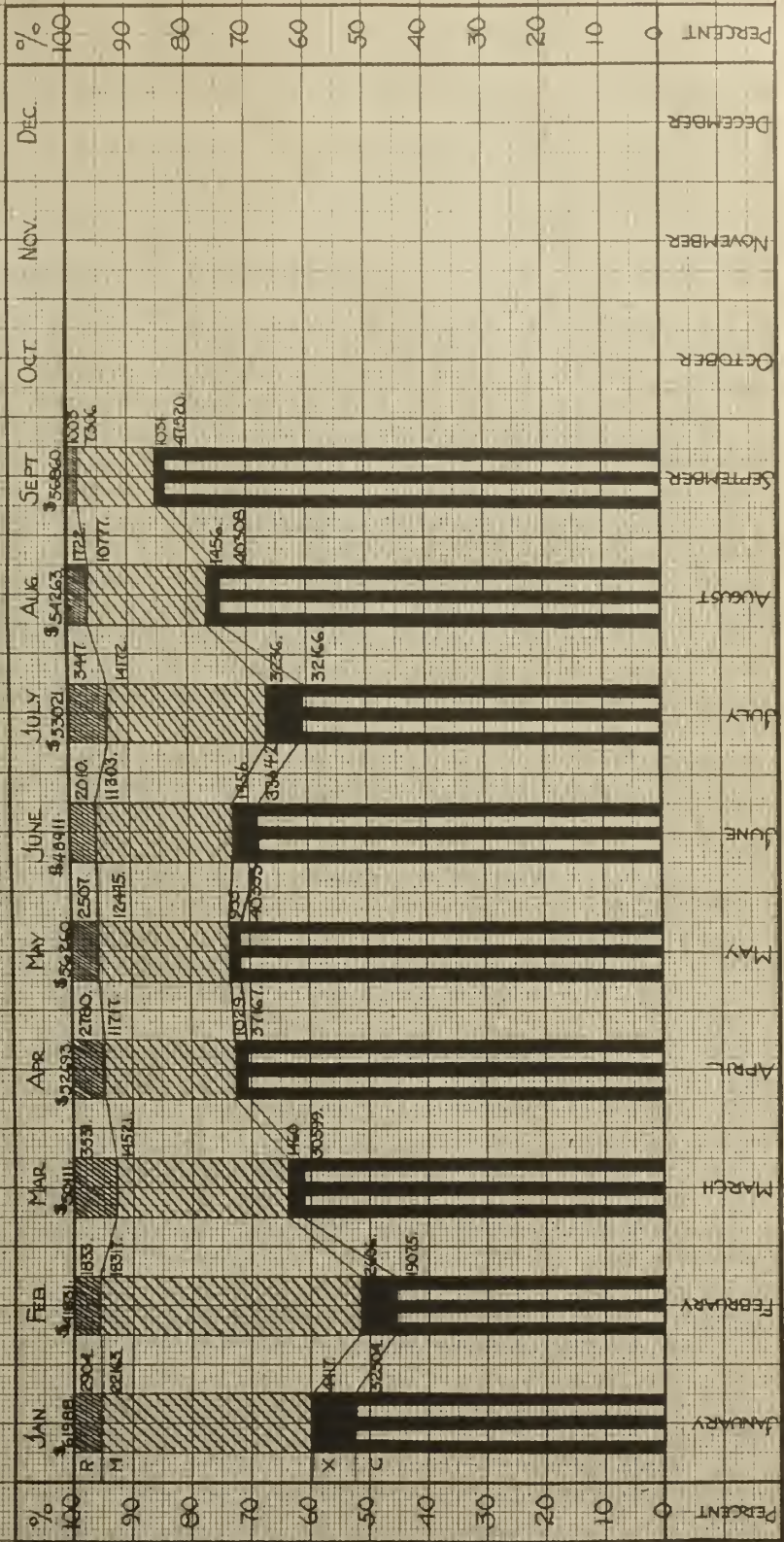
Sufficient variety of perspectives will be attempted here, to provide a fair selection of labor studies. Some of the factors of labor peculiar to the particular type of industry with which we are dealing here, would probably not appear in other production fields. Nevertheless, they are common enough in their nature to be comprehensive to any commercial reader.

The chief labor classifications of the production with which we are concerned here, are: Construction, Removals, and Maintenance. These terms are self-explanatory, and are so classified because of the part each plays toward the completion of the entire project. Equal interest should be manifested by the management in the performance of each of these classes of work; Construction, (C), to install new equipment; Removals, (X), to displace old equipment; and Maintenance, (M or R), to adjust and preserve satisfactory conditions.

A picture to show the occurrence and proportion of each of these labor divisions will be found on the chart on page 84. This chart has been constructed on a percentage basis to bring out accurate proportions, but absolute quantities have also been posted thereon, to record the absolute amounts, should such information be desired. It should be explained here that Maintenance has two sub-divisions, M for Rearrangements and Changes, and R for Repairs. In addition to the proportions each month, a

LABOR TREND (MET. DIV.) C.O.E.I. DEPT. 1929

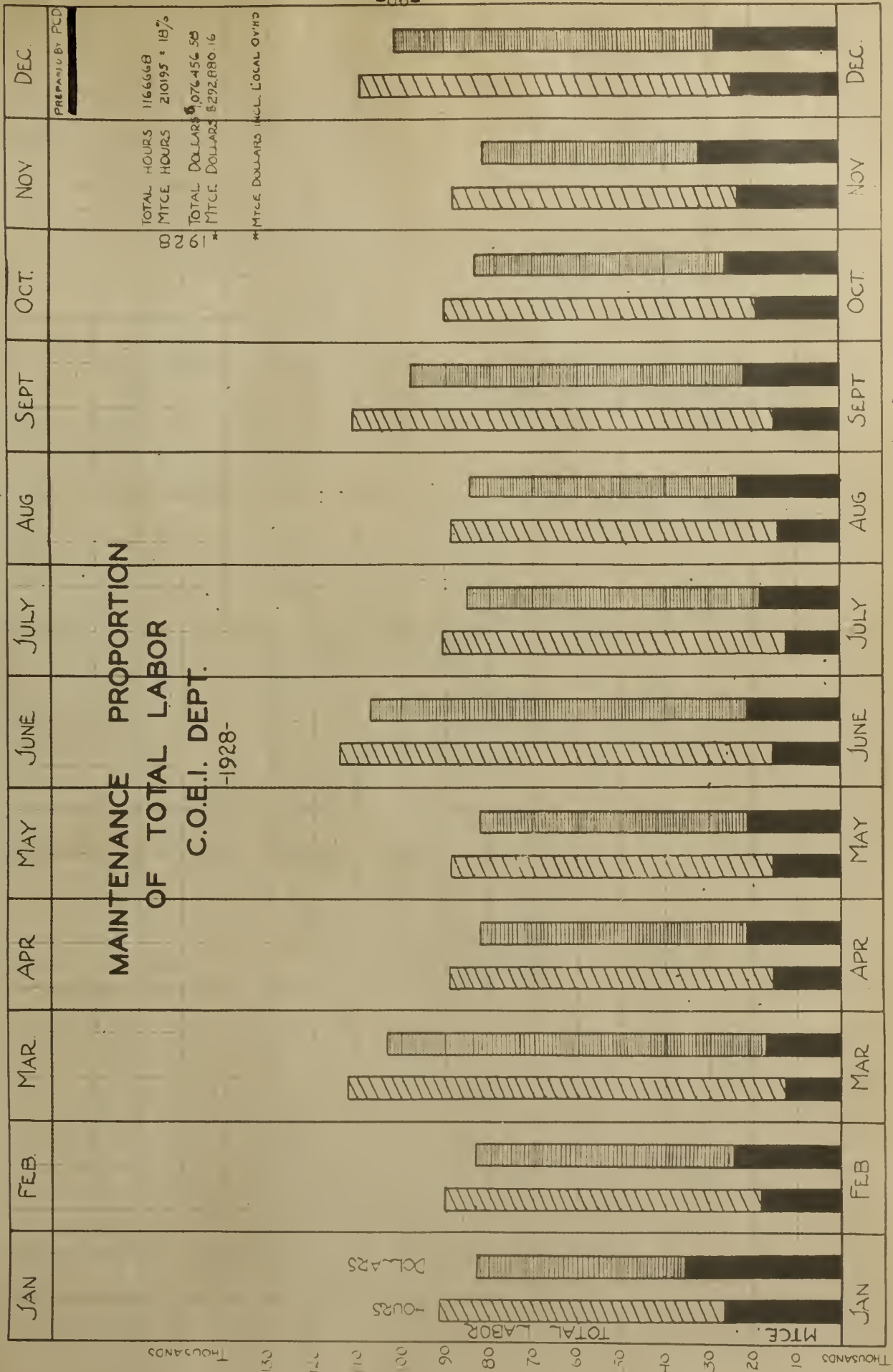
C M X R



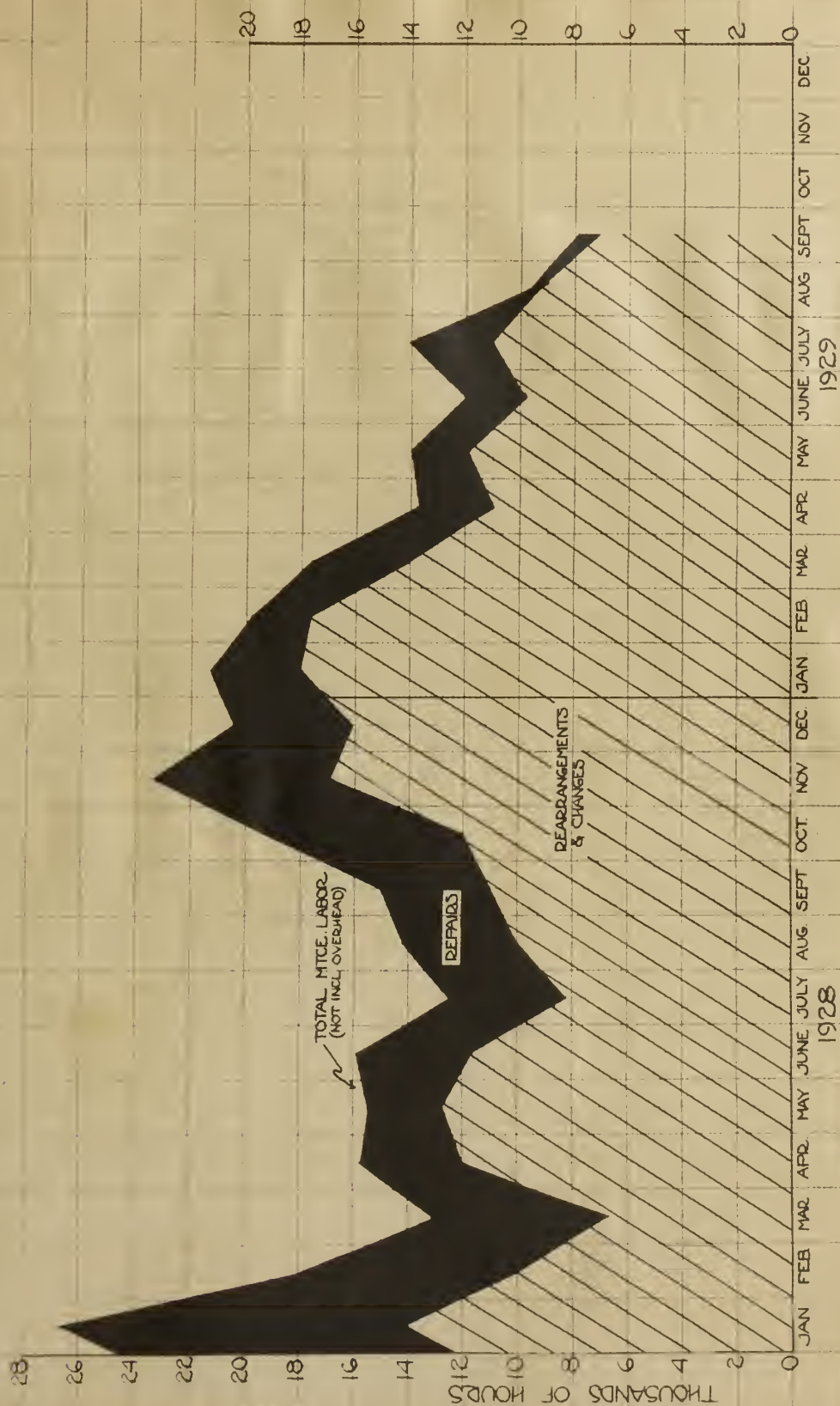
trend of each factor's size is afforded to show increases or decreases in each in volume, from month to month.

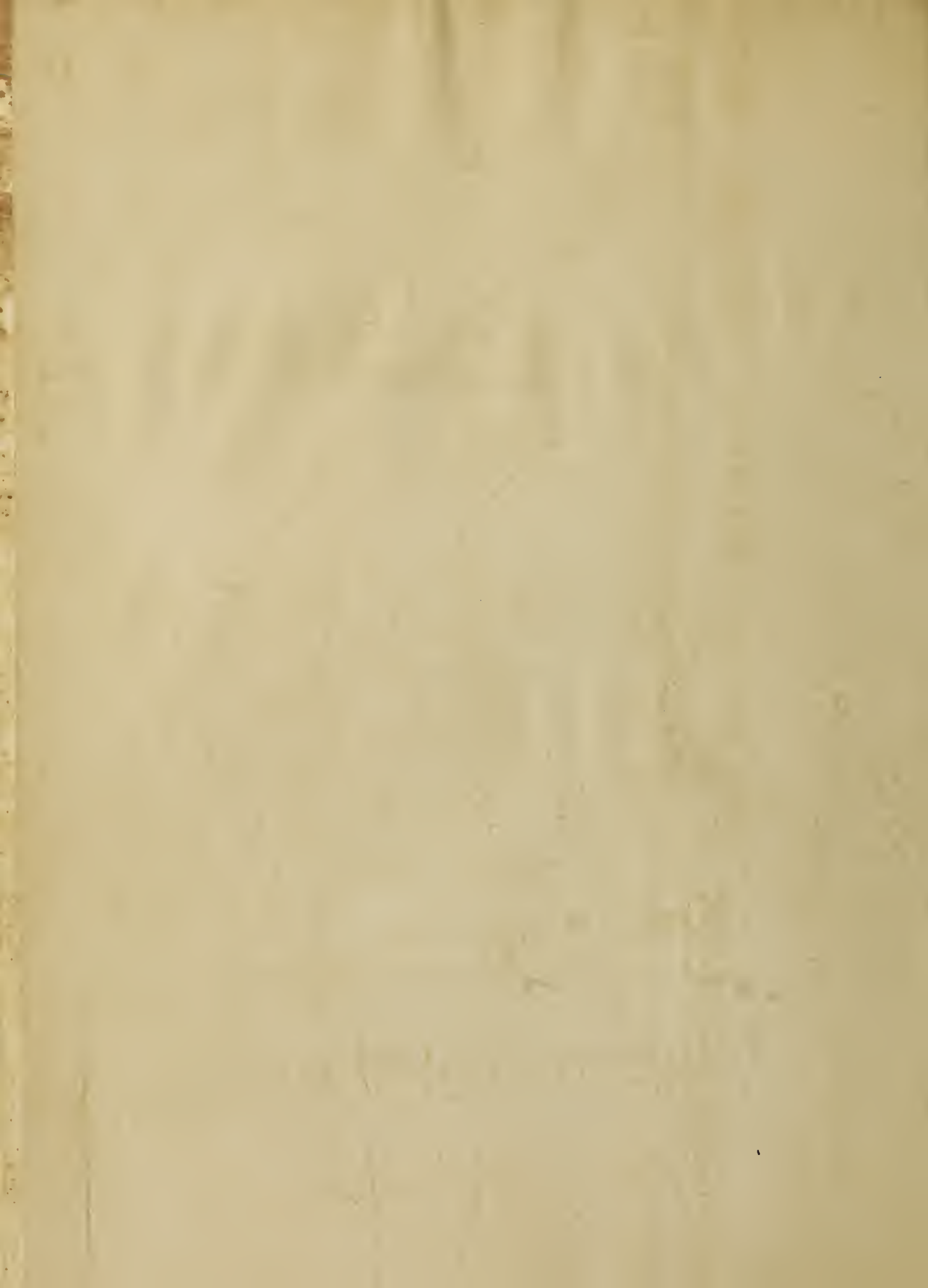
The natural tendency in efficient management would be to minimize the least profitable labor activity. Of the three mentioned, Maintenance is somewhat of a necessary evil. Consequently, a close scrutiny is made continually on such items of expense. Studies are desired and every effort is put forth to diminish, as far as possible, this unwelcome expense. Hence, such studies as we find on the next page are sought, to aid in the control of this factor. A two-fold purpose is served in constructing this chart as we have. The absolute labor figures for each month are afforded, both in dollars and hours. The absolute maintenance labor, as well as the maintenance in its proportion to the total labor, is likewise given.

Maintenance labor in its own being, might also be viewed to determine what kind of maintenance work is constituting the major activities. Considered from this angle, maintenance labor occurrence could be pictured to the exclusion of other classifications of labor. The maintenance labor view shown on page 87 brings out the relative proportions of Rearrangements and Repairs, as two distinct types of activity. The total trend is also provided, enabling the executive to note any alarming increase in this kind of work.



MAINTENANCE LABOR VIEW





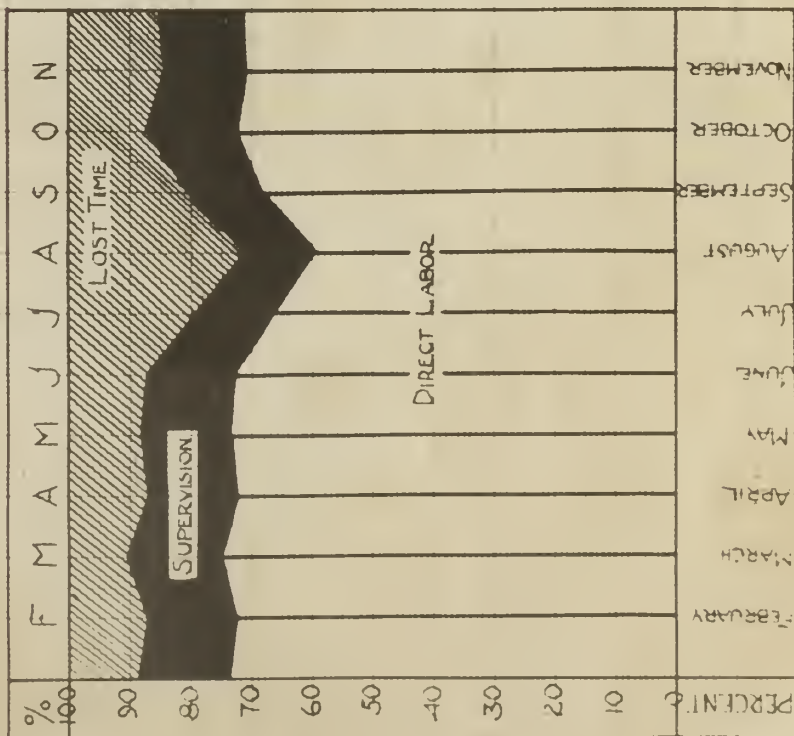
Not to permit ourselves to stray too far into the multiplex sub-divisions, we should perhaps revert to the general labor costs, and, taking the executive's viewpoint, consider labor studies of various other natures. From this imaginary pedestal, let us look in on the labor service for which we are paying. How much of the employee's time are we getting for which we pay in dollars? How much direct labor is employed and how much of the department's total time is allotted to supervision? And then, how much lost-time is being paid for by the department? All of these are vital facts. What is the state of affairs regarding these facts? A picture, showing the allocation of all salaries and wages, in this connection, should be very desirable.

The chart on page 89 tells us that supervision and lost-time absorb a certain proportion of this paid time rather consistently. True to form, lost-time increases its demands during the vacation periods, as direct labor diminishes. While considering the lost-time item the question arises in our minds, as to what constitutes this lost-time. What are the factors that go to make up this lost-time, for which we are paying? With this question uppermost in our minds, we, no doubt, look for an analysis of lost-time.

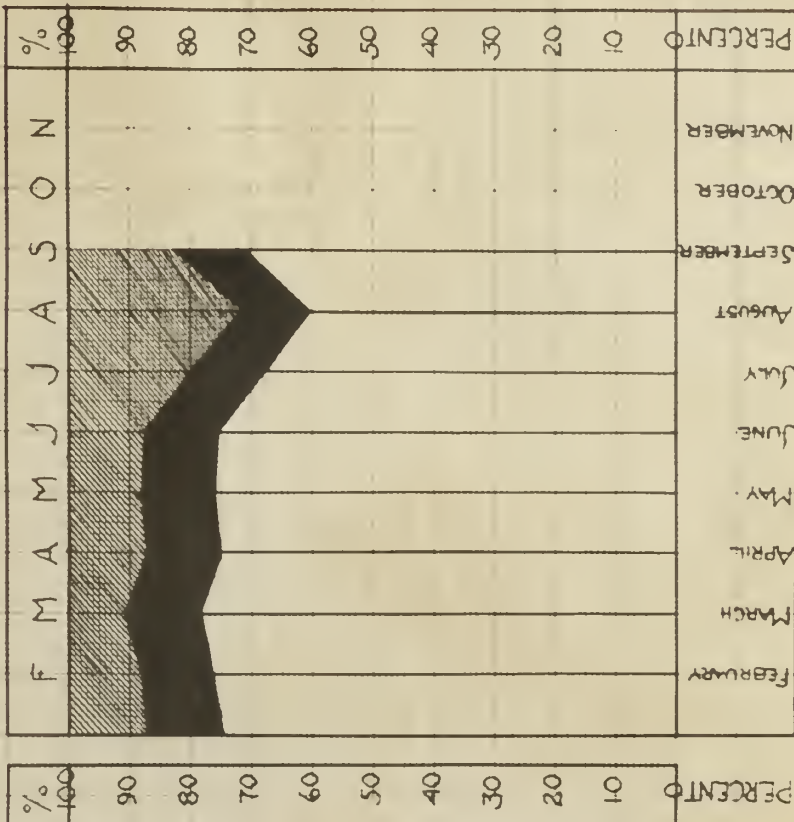
The analysis of lost-time, which appears directly after the chart on paid time, breaks down the lost-time item

ANALYSIS OF PAID TIME C.O.E.I. DEPT.

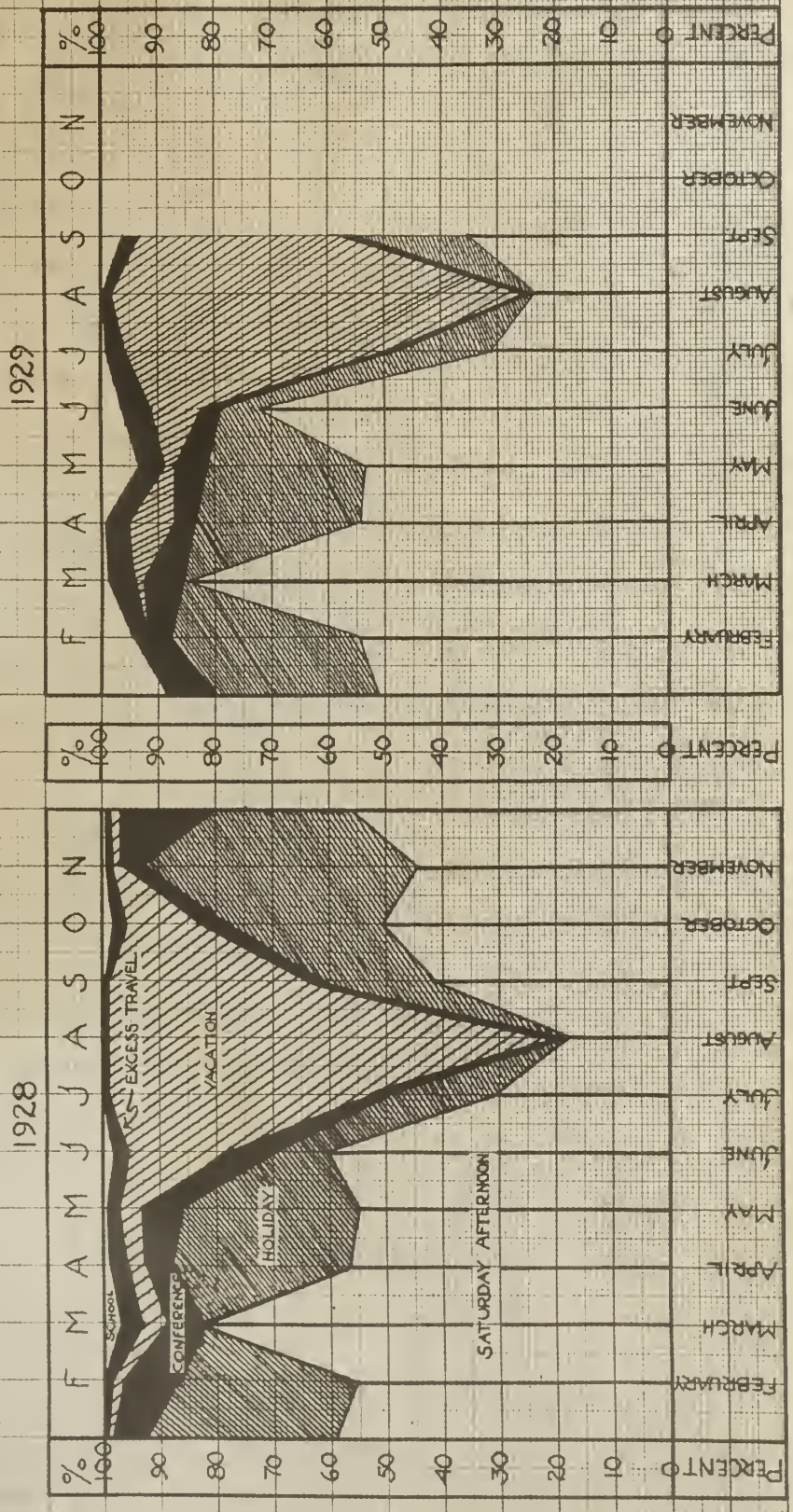
1928



1929



ANALYSIS OF LOST TIME C.O.E.I. DEPT.



into its contributing factors. The contributions to lost-time can be spotted at any given month in this chart. As we surmised, while viewing the previous paid time chart, vacations were responsible for the deep inroad on direct labor.

It would be next to impossible for an executive to obtain such a picture of lost-time from any record in figures. Figures could never bring out the striking contrasts and relative proportions manifest in this graphical portrayal. Any increase or decline in occurrence of any one of these factors incident to lost-time would be readily apparent to the reader. The approach of any of these factors to unhealthy proportions can be arrested, if the executive watches the performance by the use of this chart. It will be noted that the plotting of the several curves has ended abruptly in September of the second year. This will serve to show how the chart can be drafted progressively from month to month. By a monthly perusal of these facts, the supervisor is acquainted with conditions immediately, and in ample time to permit revisions of methods and policies.

While the labor cost problem is foremost in our minds, we might do well to attempt to find the proportionate allocation of labor costs geographically. It should be

interesting to know, and if the contingency arose it would probably be necessary to know, just how much of the labor each of the divisions is employing. Such knowledge should be an index to the extent of operations, as well as the ratio each division holds in the element of cost. The chart on the following page, constructed to picture this information, is similar in appearance to the previous Construction, Removal, and Maintenance chart. However, in this case labor is viewed from an entirely different angle, and where we considered C, X, M and R as the constituents, before, we are now dealing with the various divisions of the territory, as the contributing factors to labor cost. Like the other study, this chart gives at once the percent and absolute amounts, and provides the trend of each division incidentally.

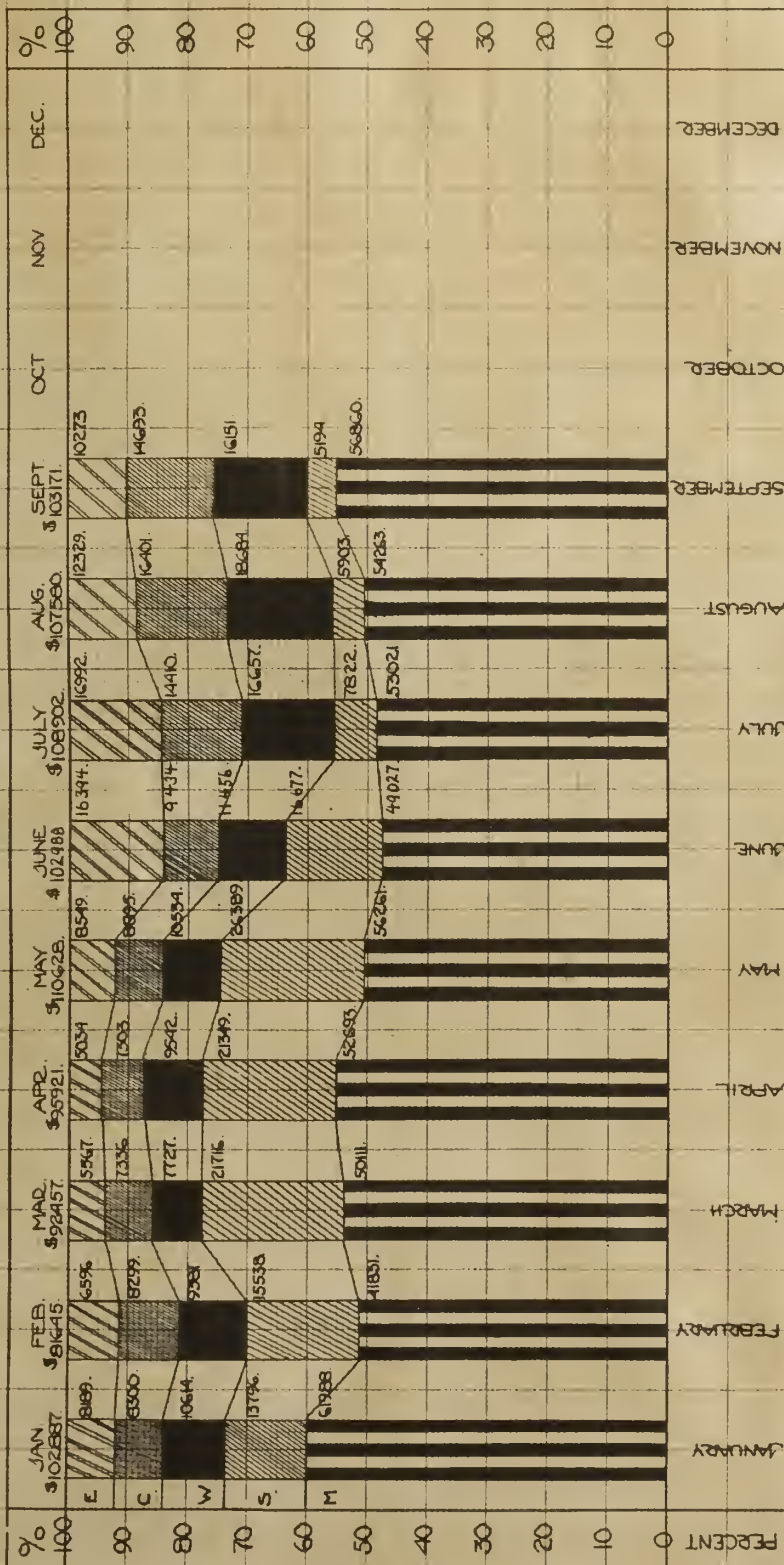
When reference was made in a previous study to the increasing efficiency of labor, the writer had in mind the study upon which we are now entering. It is expected that as the workmen become more proficient in the performance of their work, more equipment will be installed with less labor costs. Consequently we have made a study of similar projects, with this thought in mind, to determine the rate of increase in labor efficiency. In order to make the

LABOR TREND
BY

DIVISION

C.O.E.I. DEPT.

6261



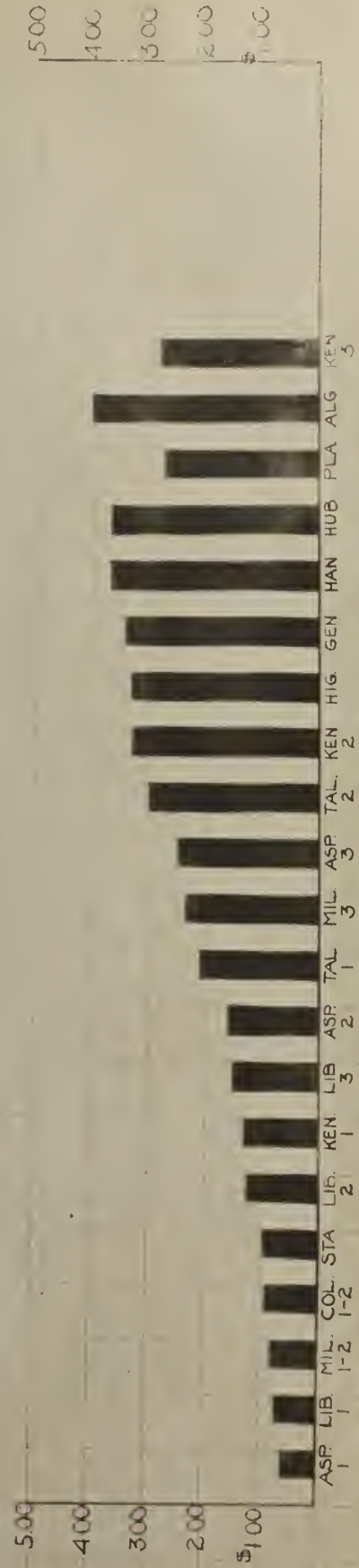
disclosures justifiable, several projects of identical nature have been selected. In this way we can reasonably expect the same, or nearly the same performance unless contingent obstacles arise, over which there can be no control.

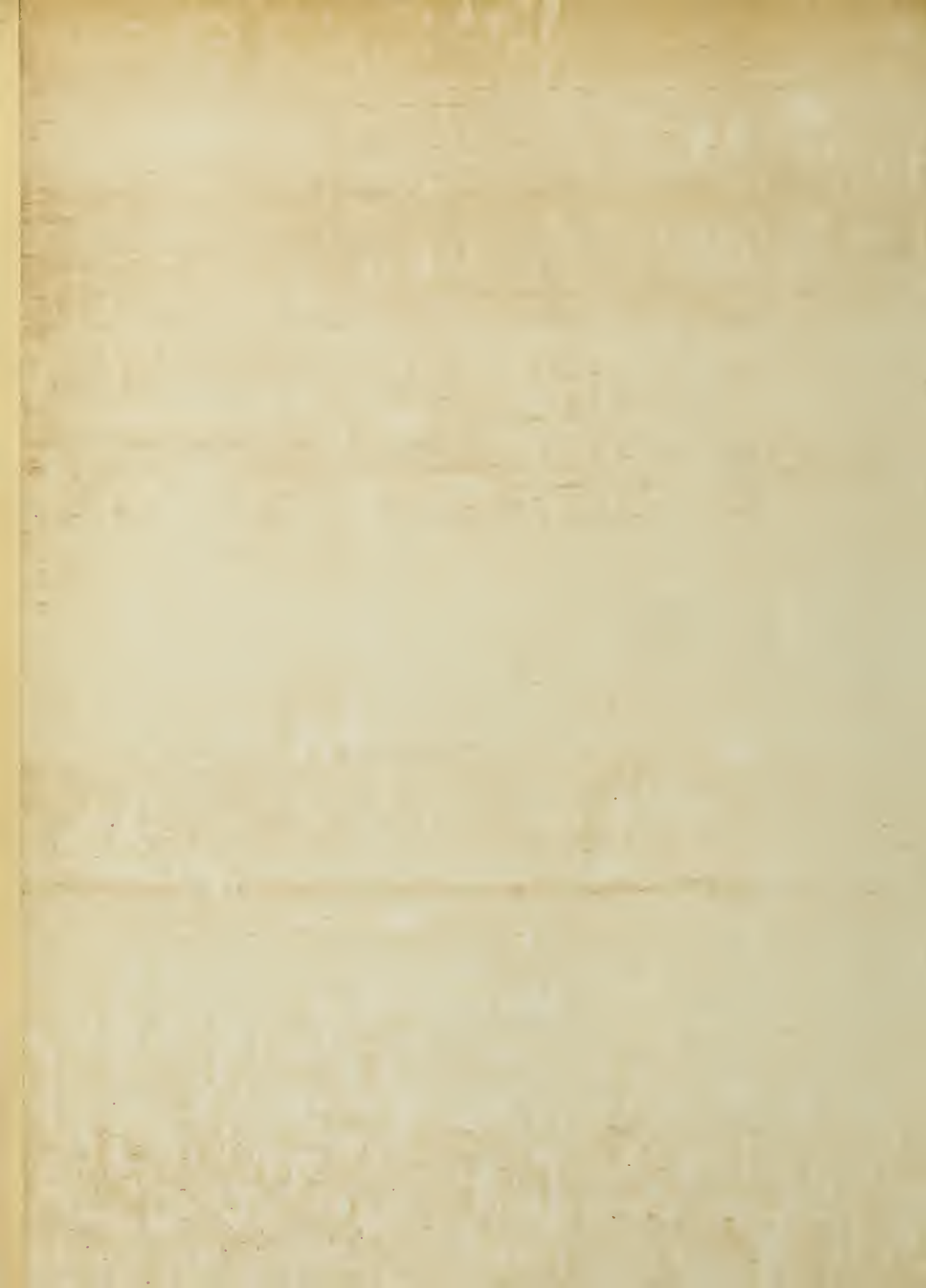
Upon constructing the chart for this study, we find that the expected increase in labor efficiency is materializing. If you will glance at the chart on page 95, our theory will be substantiated. It will be noted that an ever-increasing efficiency is realized throughout the successive installations. In the case of Aspinwall, which is the first of this kind of project to be attempted, only sixty cents worth of equipment was installed at a cost of one dollar. As each succeeding project was installed a better labor performance was resultant, until the occasion of the Algonquin job, where the maximum efficiency was realized. It has been found, upon analysis of the few later projects noticeably delinquent, that extraordinary obstacles have arisen necessitating excess voucher expense, and consequently they have fallen short of the good performance peculiar to projects at their stage of efficiency. However, the criterion can be ascertained from the general behavior of the other projects installed around that same period of time. As a measure of the marginal utility of the labor dollar spent, this is probably one of the best pictures procurable by the executive.

DOLLARS OF EQUIPMENT

INSTALLED

PER \$1.00 OF LABOR-OVERHEAD AND VOUCHERS





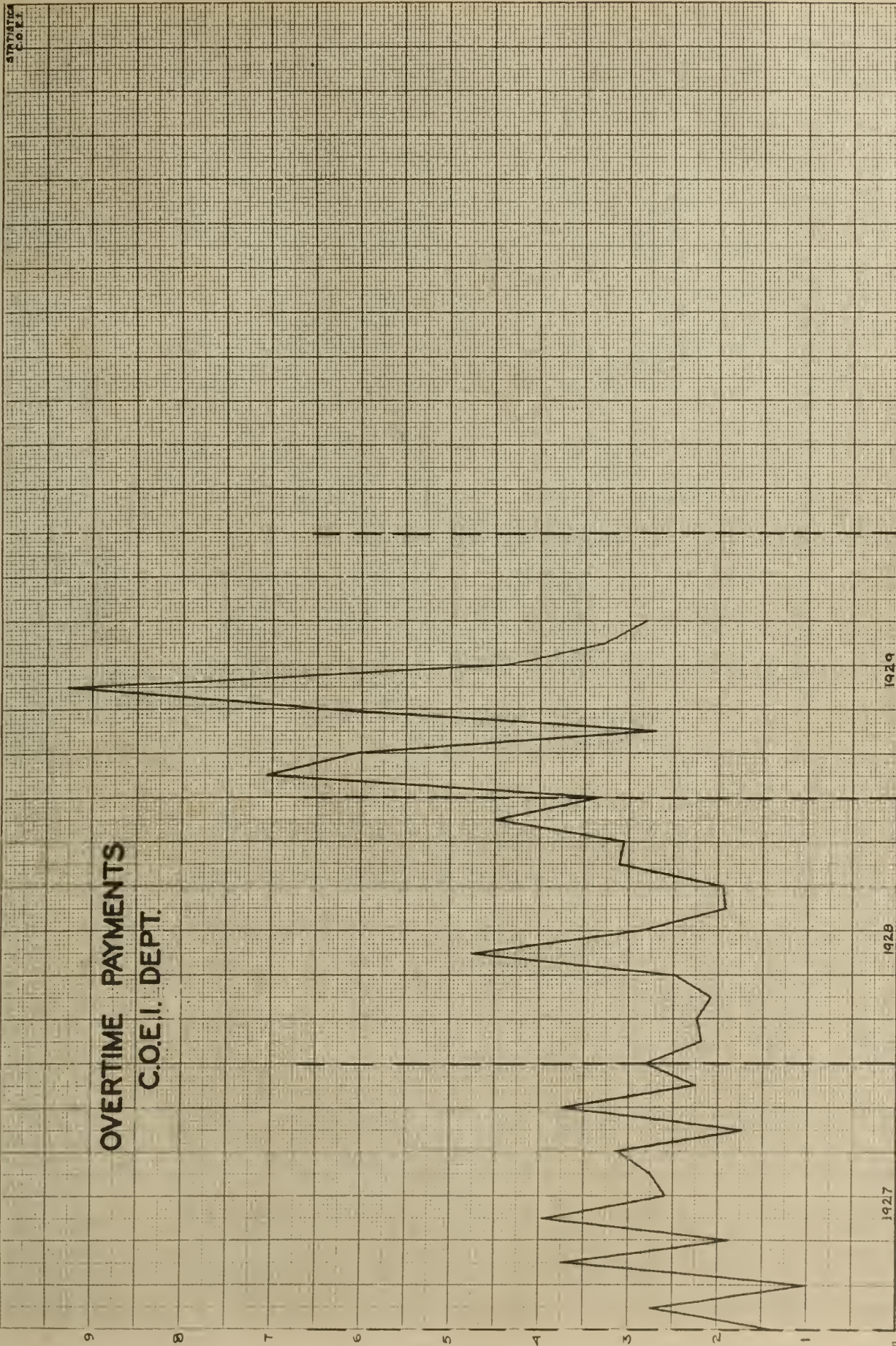
An item of labor cost incurring inflated labor expense, is the overtime feature. This is probably one of the factors presumed to be minimized, as far as possible, because of its feature of double or semi-double remuneration. Overtime was mentioned merely as a passing comment in our treatise of the payroll, but here it should be considered in its own right as a factor in labor costs.

The necessity for overtime work usually denotes, either faulty scheduling and inadequate manpower, or, the contingent appearance of abnormal conditions. Whatever its cause may be, it is, to the management, a necessary evil. In order to assure the intelligence of the behavior of the overtime curve, studies of the subject become necessary. To have the general curve on overtime performance, the executive has a timely check on this unwelcome expense, should it, at any time, begin to assume alarming proportions. A three-year view of its inclinations is to be found on page 97, where it will be noted that considerable fluctuation is in evidence, but, nevertheless, inclining upward. Whatever this indicates to the executive who understands the conditions in his department, we cannot say. Perhaps the many other studies his statistician is providing him with will show conditions justifying this abnormal overtime performance.

STATISTICAL
COPIES

OVERTIME PAYMENTS
C.O.E.I. DEPT.

THOUSANDS OF DOLLARS



STATISTICAL
COPIES

STATISTICAL
COPIES

Before passing from the specific subject of Labor, we should present at least one study on Custom Work. It should be explained, perhaps, that the department in which we have been making these studies, makes a practice of performing certain extra work at the request of subscribers, which is not necessary to the provision of service, and for which the subscribers are later billed. Because the cost of this work is not charged to the Company as any permanent or legitimate item, this function and its allied features are sought to be kept apart from ordinary activities of the department. Hence, the desire for pictures of its occurrence, as an independent function, is anticipated.

For the purpose of providing the management with the story of custom work throughout a given period, the chart on page 99 has been prepared. In the desire to know when and how much custom work is occurring, the person interested need only to look at this chart and the picture is provided at a glance. The amount of this work as well as the general trend of its occurrence, is found in clear and interesting form. In this picture we note that there was no custom work performed in the first three months of 1928, and that in April, four hundred dollars worth appears. In the following month, May, we find one hundred dollars worth shown, followed by two hundred

STATISTICS
C.O.E.I.

CUSTOM WORK OCCURRENCE

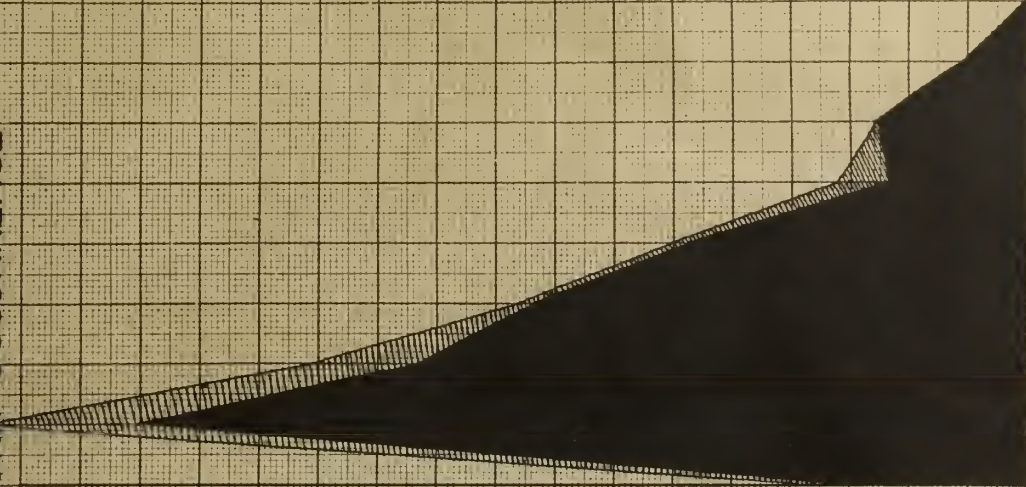
THOUSANDS OF DOLLARS

REMOVAL
OR MTCE.

CONST.

JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1928 1929

34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0



in June. No further custom work occurred until September, when it amounted to twenty-three hundred dollars, of which about nine hundred was for removals and maintenance, and the balance, construction work. In February 1929, the work involves thirty-five thousand dollars, an unprecedented amount. It is manifest that any such occurrence denotes abnormal conditions somewhere, whether on the customers' end or our own, and is deserving of investigation. It is hardly likely, that, at this particular time, the public suddenly desires so great an improvement in conditions incident to telephone service. Be that as it may, we have provided the signal facts, and the executive has the information to acquaint him with the condition of affairs in this connection. The statistician's work is done, unless the management sees fit to call upon him for further analysis of the subject.

Material Costs

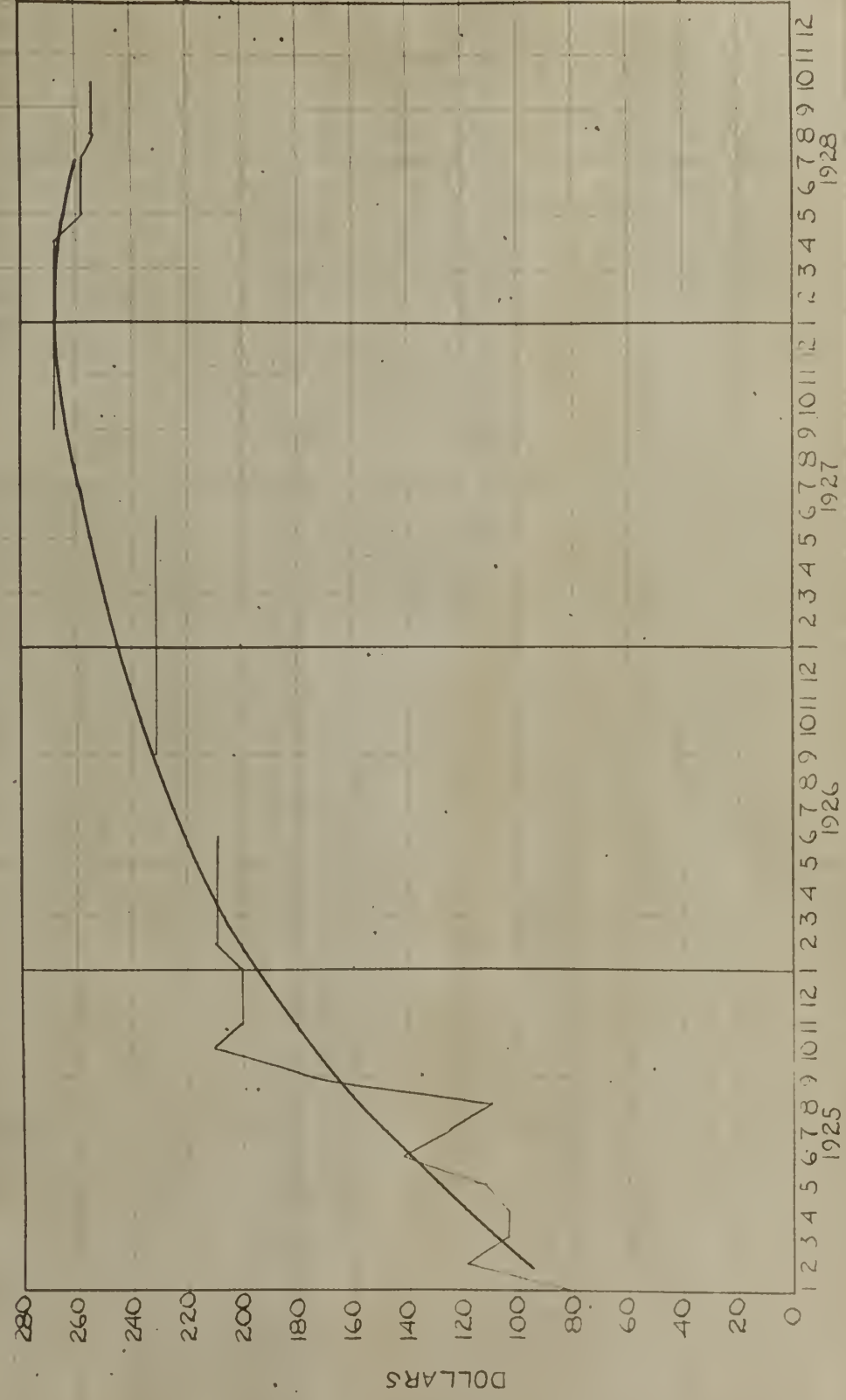
In our consideration of material costs, it must be borne in mind that, due to the different types of offices installed, varying costs are likely to be realized. Because of rather standard costs, however, the material question is not much of a worry to the management. The element of quality should of course enter in ordinarily, but in the particular industry with which we are concerned, this can be pretty well

assumed by reason of the fact that material specialists are constantly studying the adaptabilities of all material items, with a view to improvement. Consequently, any thought or anxiety along these lines can be averted by the production man and all of his energies can be directed toward the other factors in production. Notwithstanding, he may want to view the material factor in the part it plays in productive efficiency, and in its more passive sense.

Material was considered in our previous pages in connection with labor efficiency, and might be viewed here in much the same light. It should be interesting in this connection to know the value of equipment installed per man-week. On the next page, a chart portrays this picture over a period of several years. This curve corroborates our previous bar-chart disclosure of the increasing labor efficiency, in that it shows a constant increase in the value of equipment installed by the use of one week's labor.

Further explanation of this chart should not be necessary, and we might pass on to a slightly different study of material costs. In this case, we will give a picture somewhat in reverse form, to show the decreasing cost of installation, rather than the increasing efficiency of labor.

VALUE OF EQUIP. INSTALLED
PER MAN-WEEK
(MACH. SWITCHING ONLY)

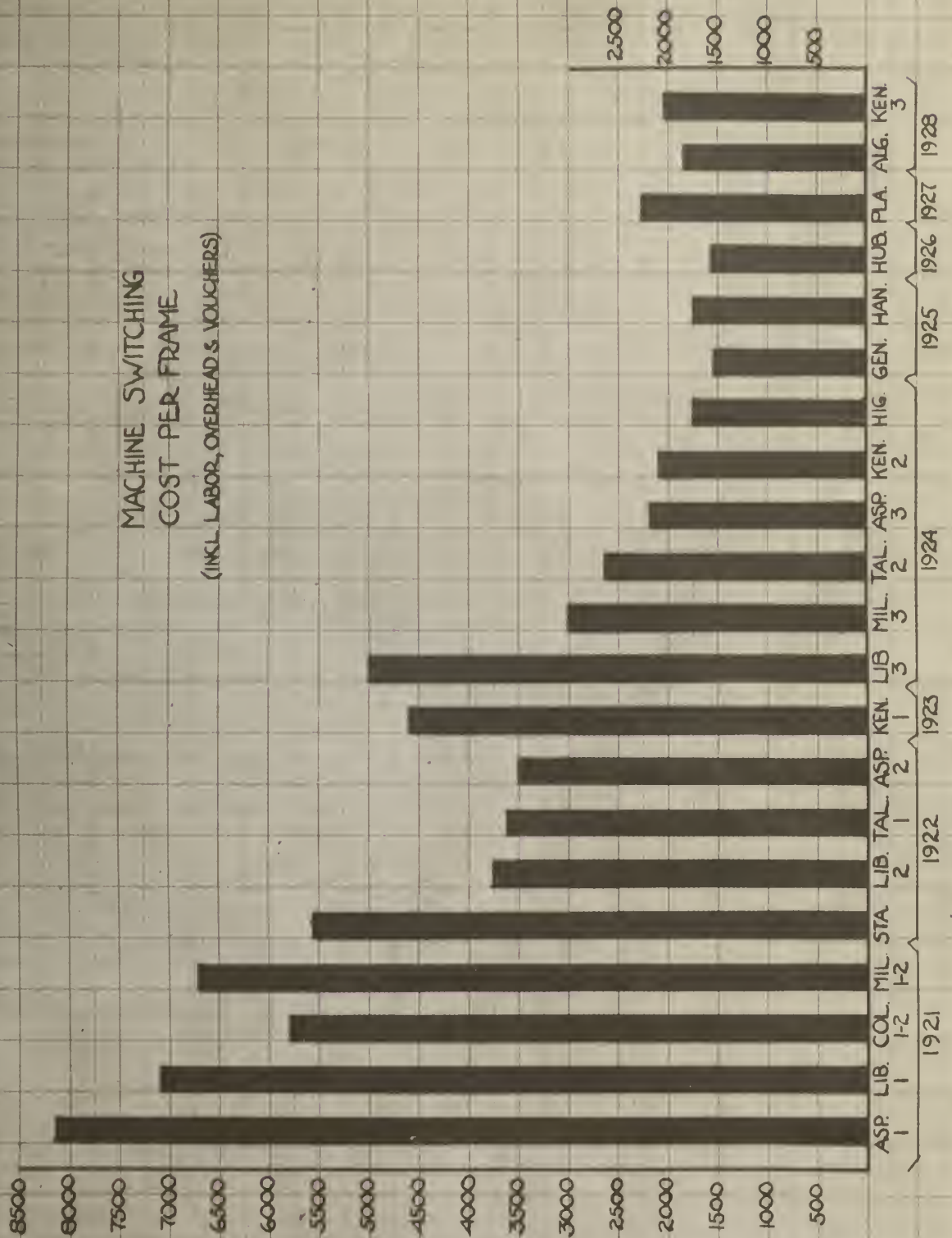


The results appear to be the same, as will be noted on page 104, where a consistent decrease in cost will be apparent. To revert to the chart on page 95, it will be noted that the same group of projects were used, and a comparison of these two charts will show a consistent story. Our conclusions naturally would be, after examining both of these charts, which, incidentally, were constructed independently of each other, that a decidedly improved performance is in evidence.

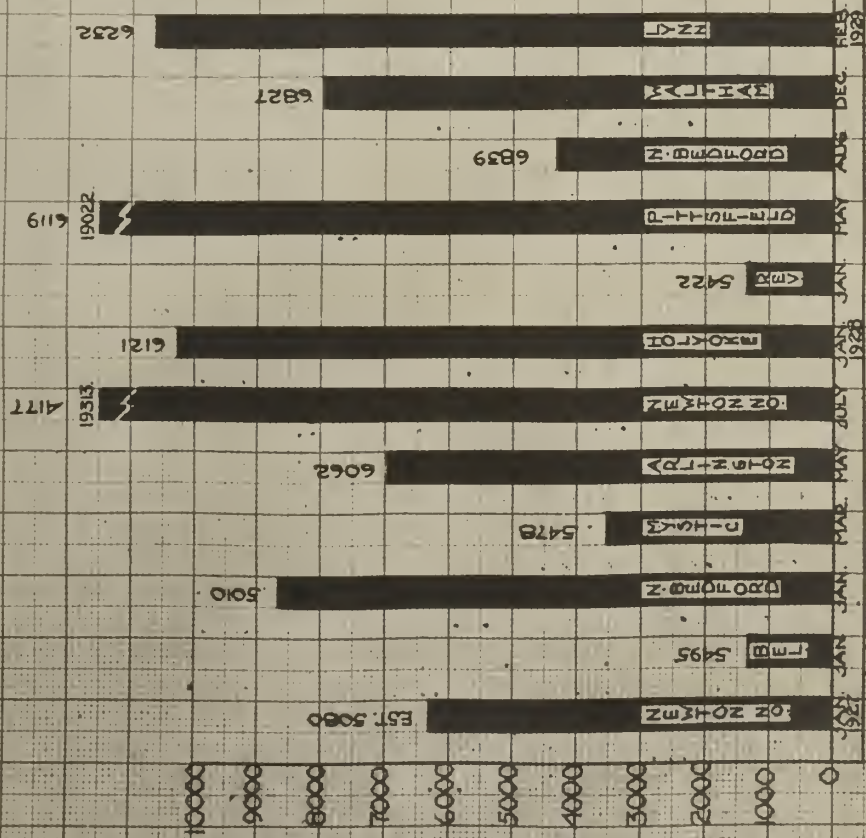
The previously mentioned studies were applied to machine switching offices, where facilities for even performance of work were provided. In a similar study on manual offices, it has been found that no such consistent improvement is manifest. In the bar-chart to be found on page 105, it will be noted that uneven lengths are found in the bars representative of installation cost of like projects. It would seem that no standard or nearly standard cost could be established on jobs of this kind. The fact that no consistency exists here does not mean, necessarily, that none should, and right here we have a problem for the executive. Perhaps it is a reflection upon the labor or supervision, and then, it might be due to some irregularity of material peculiar to this type of installation.

Whatever the cause of this condition might be, it

MACHINE SWITCHING
COST PER FRAME
(INCL. LABOR, OVERHEAD & VOUCHERS)



COST PER SECTION #1 MANUAL OFFICE



is for the management to find out, now that the condition has been disclosed by this definite picture. Without such specific comparisons, the executive might know, from cost figures, that one job cost more than the next, but he would naturally impute the fact to differences in size or area demands. Regardless of how many sections were installed, the cost per section is a definite unit cost, a perspective which would have been lost, undoubtedly, in the perusal of general accounting figures.

Material and its costs is, ordinarily, a major factor of production, and is considered usually as one of the chief items of cost. This is so in most industrial concerns manufacturing products for sale. In the telephone industry, however, it does not affect the cost of the product in such a direct way - the product being service. Material used, incident to telephone service, goes into plant and is consequently a very remote factor as far as the public is concerned. Furthermore, material for all telephone plant is prepared and provided by the Western Electric Company - the contractors who relieve the telephone people entirely of any necessity for planning or experimenting on material. In view of this practice, very few material cost studies are likely to be required in the telephone end of the

industry. Therefore, we have considered only a few likely
to be of value to the telephone installation supervisor.

CHAPTER VIII

Other Contributing Factors to Cost

Incidental to all direct production costs, especially where large-scale performance is had, certain overhead and administrative expenses are necessarily involved. Even in the smallest of businesses this item is ever present.

General Overhead

Overhead expense is an item that cannot be ignored, and for which real money is spent. Whatever it may be termed by different concerns, it is still existent, and is certainly present in the order of things with which we are concerned here. Not to ignore its presence, and to emphasize its significance, consideration should be given this expense item in one of our studies. The value of overhead and administrative cost studies is just as great, from a standpoint of costs, as is the study of labor, manload, or material.

Many items go to make up the overhead costs, and each concern has expenses peculiar to its particular industry, which are oftentimes foreign to the industry of a neighboring

business. In our consideration of this cost factor, we will, of course, concern ourselves only with the particular items of overhead expense incurred by the industry holding our interest here. Although overhead has been dealt with incidentally in previous studies, it has been pictured only as one of the contributing factors in operating costs. To break it down into its constituent parts, however, should make it presentable in the more desirable form, should occasion for its need arise.

In order to clarify what will probably be confusing presently, it should be explained that each operating unit is usually burdened with a certain proportion of general expense, for which it is not directly responsible, but which, nevertheless, is necessary by reason of the general administration of all operating units. This general expense, in certain proportions, and coupled with other staff expenses, is allocated to the various operating departments, to which the general supervisory attention was given. Hence, some of the items of overhead, shown in the table on the next page, are not expenses incurred by this particular department. Nevertheless, the department must bear its proportionate share, and, consequently, the executive responsible for the costs in the department is naturally interested to know what these charges amount to.

In Table E, below, local administration or direct supervision cost is also shown, together with the voucher costs.

Table E

Analysis of Overhead Charges Monthly

	1928 Aver.	1929 Aver.	*	1929 High	1929 Low	This Month	Last Month
Genl. Adm.	2731.	2975.	+ 8.9	3708.	2352.	3636.	3708.
Plant Adm.	7725.	10374.	+34.3	17432.	8115.	10541.	10796.
Plant Eng.	3488.	12831.	+26.8	17739.	8536.	14009.	12671.
Genl. Eng.	16097.	14763.	- 8.3	18079.	6303.	17438.	17341.
Tool Exp.	<u>5531.</u>	<u>5179.</u>	- 6.4	<u>6796.</u>	<u>3786.</u>	<u>4879.</u>	<u>5643.</u>
Genl. Ovhd. Tot.	35572.	46183.	+29.9	52303.	38995.	50502.	50161.
Loc. Supv.	23399.	20421.	-12.7	21388.	19020.	19188.	20832.
Vouchers	<u>13697.</u>	<u>17060.</u>	+24.5	<u>20112.</u>	<u>15040.</u>	<u>16804.</u>	<u>20112.</u>
Total Overhead	72668.	83664.	+15.13	93803.	73055.	86494.	91105.

* Percent of 1929 Average, above or below 1928 Average.

It is not necessary that we bother with the first group of general overhead items, for the control of these are beyond the authority of the department. Suffice it to say that the Departmental Head can be constantly informed regarding these extraneous accounts and will know to what degree they are inflating his cost figures.

The last two items shown in Table E, are entirely under the control of the department and can, therefore, be governed by the department administration. Local supervision has been sufficiently considered in previous studies and can probably be side-tracked so that we might proceed with a few studies on the voucher item, which is often a troublesome and somewhat intangible cost factor.

Voucher Expense

By reason of its diversified and emergency uses, the voucher proves to be a somewhat intangible medium to cost. Not only does it serve to fill in the gaps for all of the regular items of expense, but it also permits of use by all employees and in all locations. It can be readily seen how any such instrument is very apt to prove troublesome when control of costs is sought. Due to its multifarious applications, the voucher cannot very well be watched in its piecemeal contributions to cost. Consequently studies of the situation are advisable, in order to "keep a finger on the pulse" of voucher behavior.

The chart on page 112 portrays two distinct angles of voucher analysis. On the one hand, we find voucher costs split into the component items of voucher expense. On the

The first part of the report is devoted to a general survey of the situation in the country. It is followed by a detailed account of the work done during the year. The report then goes on to discuss the results of the work and the conclusions reached. Finally, it contains a list of references and a list of names of the persons who have assisted in the work.

General Survey

The first part of the report is devoted to a general survey of the situation in the country. It is followed by a detailed account of the work done during the year. The report then goes on to discuss the results of the work and the conclusions reached. Finally, it contains a list of references and a list of names of the persons who have assisted in the work.

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other hand, there is a "break-down" by divisions. In the former, the proportions of the various voucher items are shown, and, in the latter, the relative proportions of the divisions are marked off, providing the sectional application of voucher expense. In each of these parts, the total voucher costs are shown for each month, in such a form as will permit the comparison of monthly expenditures.

With the aid of this chart, it should be a very simple matter for the executive to watch voucher behavior from month to month, and should any alarming condition arise, he would be cognizant of the condition in time to curtail its damaging progress.

It will be recalled that in a previous study of resident labor distribution, an unfavorable condition was disclosed. In that study we found that a considerable proportion of the employees was employed in foreign and distant divisions. Because of their distant assignments, these men were incurring considerable voucher expense. This contention of ours is borne out now in this voucher study, where we find a somewhat heavy voucher expenditure each month, and especially the board item. It will be noted that the board item averages between 45 and 50% of the total voucher costs each month.

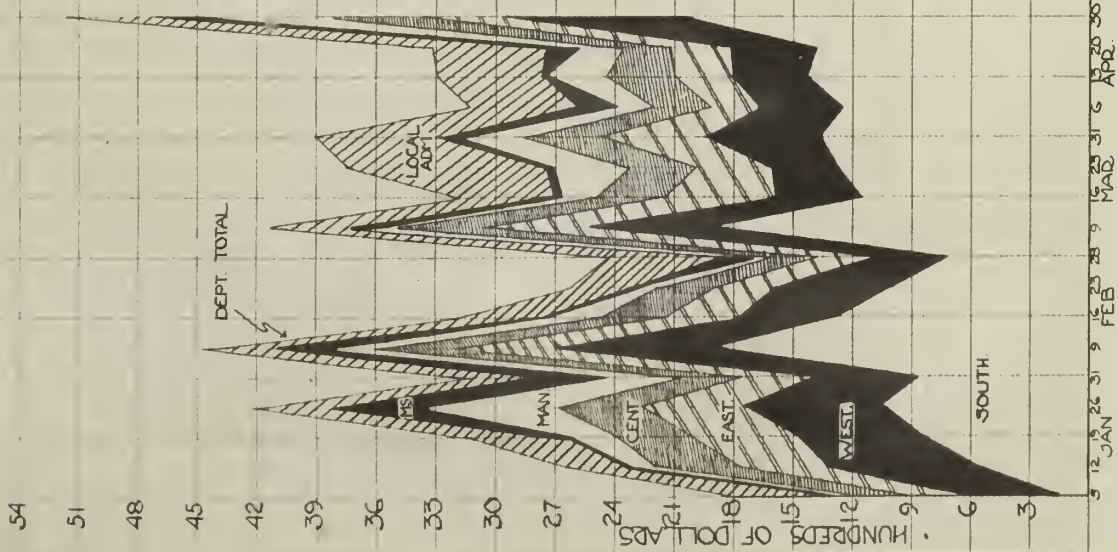
Had the executive taken stock of manload conditions,

as disclosed by the manload studies, this excessive board expense would not prevail. Assuming that no manload studies had been prepared for him, he would now, in his attempt to curtail voucher costs, begin to trace them back to the causes. Eventually a study of resident labor distribution would be inevitably necessary. In assuming the role of statistician for this imaginary executive, however, we have foreseen this contingency, and in anticipation of the natural desires of the progressive executive, we have prepared valuable charts on the chief phases of the industry.

The voucher situation might be viewed from other angles, one of which might just as well be considered now. In the form of the trend curve, the same data will be found on page 115. Although this picture tells no more than the previous chart, it does depict the divisional performances in a different manner, providing a good trend curve of total voucher costs. Upon reading this chart it is possible to pick out the heavy occurrences of voucher expense, and should absolute amounts be desired in any division, they can be had by counting the number of squares covered.

It seems that the Southern Division constitutes the largest proportion of voucher expense. If a complete survey of this division's costs was made, it would be found in the

VOUCHER COST-BY DIVISION C.O.E.I. DEPT. 1929



final analysis, that imported labor and its consequent board expenses were largely instrumental in causing the heavy voucher costs.

Before passing from the voucher studies, it should probably be explained here, that while some of the voucher items might be eliminated, there are others that could not. An attempt could be made, of course, to minimize all of the expenses, as far as possible, but it is manifest folly to say that so large an enterprise could perform without any voucher expenditures. Outside labor is necessary in cases of masonry, trucking, and certain iron work. Emergency material will be necessary at times, and cartage charges go hand in hand with material costs. Miscellaneous nuts, bolts, and boxes are needed from time to time. Travel is necessary, with its incidental meals and lodging, where supervisors have outlying districts. The maintenance of motor vehicles incurs some expense. All of these voucher expenses should be legitimate ones, if kept within reasonable limits. However, that is for the management to decide. The statistician's job is done when he portrays the facts.

CHAPTER IX

Schedule Studies

One of the foremost interests of any management of large-scale production is scheduling. This function is becoming more and more popular every day with nearly all large, progressive concerns. As a means of controlling schedule performance, facts are required concerning this function. Although there are numberless ways of producing schedule facts in statistical form, time and space will only permit examples of a few here.

Current Projects

To begin with, we should naturally be interested in the relative proportions of Estimates and Routine Orders. It should be explained here, that all jobs costing over \$2,000.00 are known as estimates, and the smaller ones, routines. A knowledge of their relative proportions is essential to the proper allocation of the program budget. Because of the fact that several small jobs are costly, an attempt is expected to be made to control the issue of these small jobs as much as possible. Several small jobs might be grouped together to constitute a large one, with

considerable reduction in cost. This being the case, a constant control over the issue of jobs is essential.

In this connection a study has been made of these projects, and is presented below in tabular form.

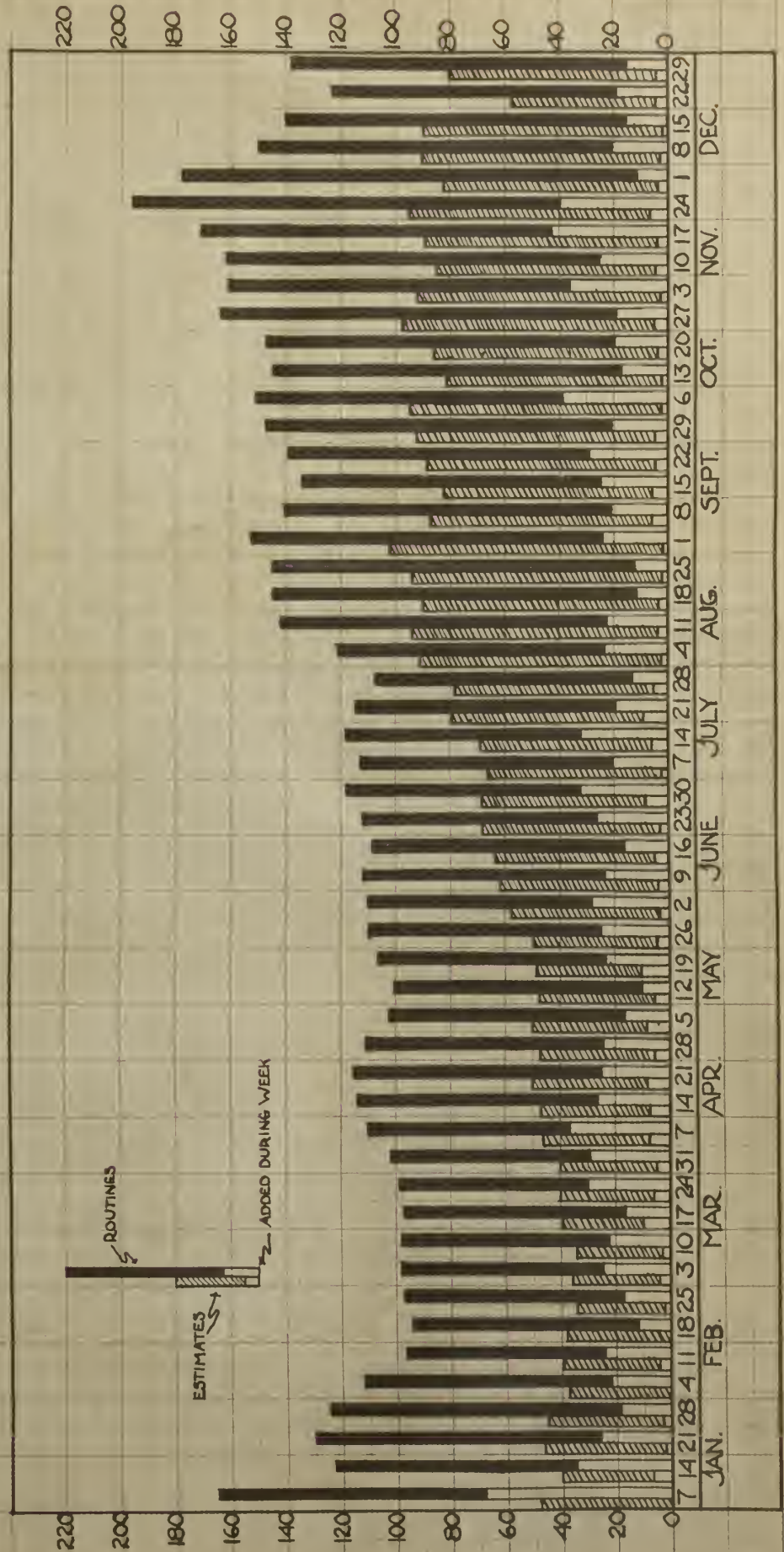
Table F
Proportions of Estimates and Routine
Orders by Divisions

<u>Division</u>	<u>Estimates</u>		<u>Routines</u>		<u>Total</u>	
	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>	<u>No.</u>	<u>%</u>
Eastern	40	25.2	119	74.8	159	9.27
Western (Vt.)	21	19.7	85	80.3	106	6.12
Western (Mass.)	38	16.8	188	83.2	226	13.05
Central (N.H.)	50	25.2	148	74.8	198	11.44
Central (Mass.)	19	17.7	88	82.3	107	6.18
Southern	22	14.0	135	86.0	157	9.07
Met.Manual	100	17.6	468	82.4	568	32.63
Met.Dial	23	22.3	80	77.6	103	6.0
P.B.X.	19	17.6	89	82.4	108	6.24
Total	332	19.1	1400	80.9	1732	100.

This table shows the number and percent of each kind of job and also the percent each division's jobs are of the total. There appear to be only 332 estimates against 1400 routines. This is a natural condition of course, because the small jobs cannot be held up when they become necessary. To bulk these into estimates, it would be necessary to wait until \$2,000.00 worth of work was accumulated in the requirements of one particular central office. The service in the particular

PREPARED BY:
APPROVED:

TOTAL JOBS IN FIELD C.O.E.I. DEPT. 1928



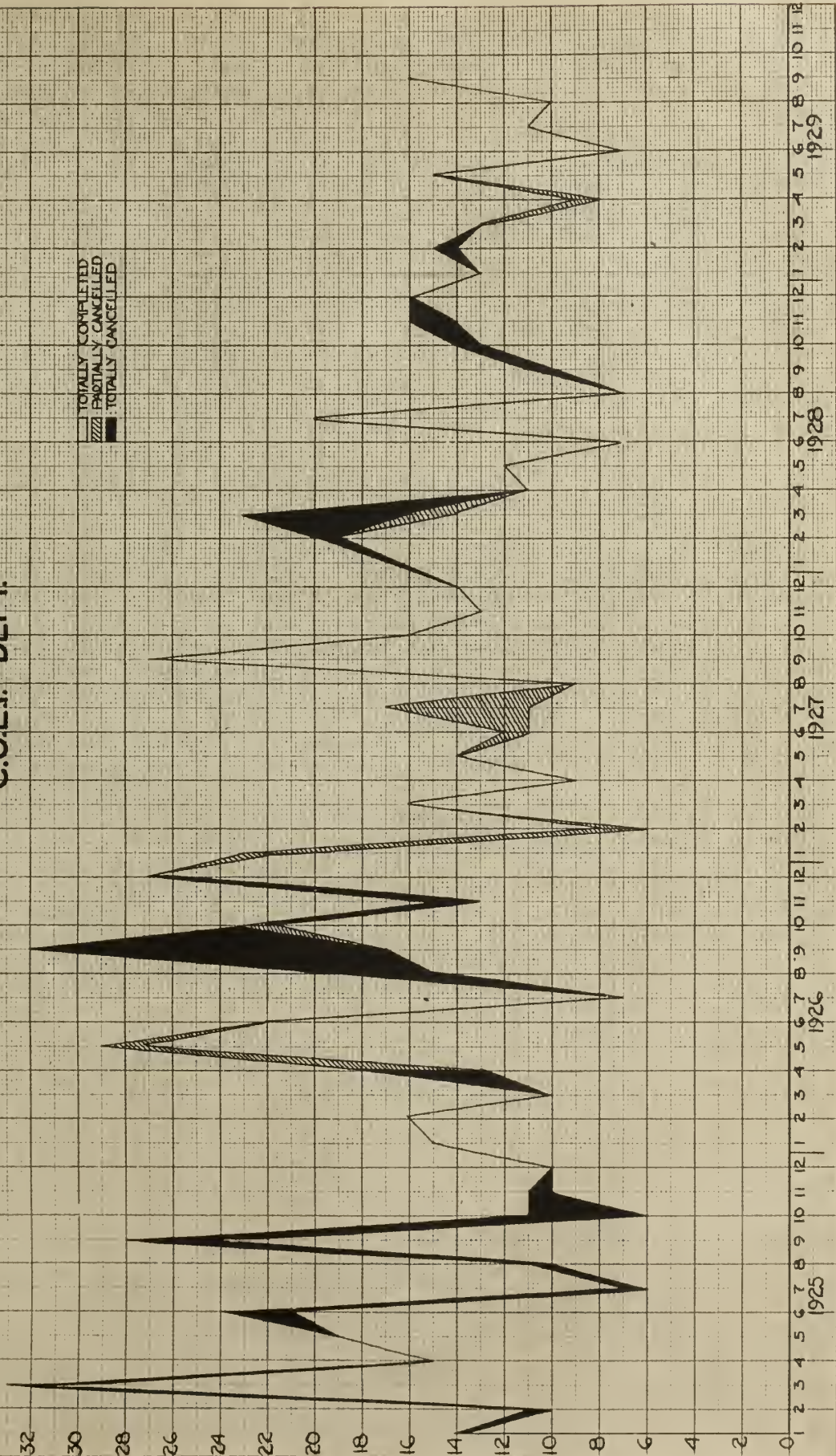
exchange would certainly suffer before an estimate appropriation would be warranted. Nevertheless, an attempt should be made to do all the work possible under estimates and thereby eliminate or reduce the costly details characteristic of routine orders.

As a result of these presumptions, there should be a call for pictures of the prevailing ratios, as well as frequency facts on all projects. The chart on page 119 shows the frequency of all jobs, and not only gives the ratios of each kind, but also informs of new additions weekly. This chart should be self-explanatory, and therefore, we need not elaborate any further. Schedule factors are so numerous that we might do well to pass on immediately to other studies in this connection.

A knowledge of the trend of completions and cancellations is usually of paramount significance to the executive controlling production. Hence, a picture of this performance should not be presented in vain. Consider this chart on the next page and note the fluctuation from month to month. There seems to be no normal or average rate of completion according to this curve, although a smoothing tendency is manifest toward the later months.

STATISTICS
C.O.E.I.

COMPLETION OF ESTIMATES C.O.E.I. DEPT.

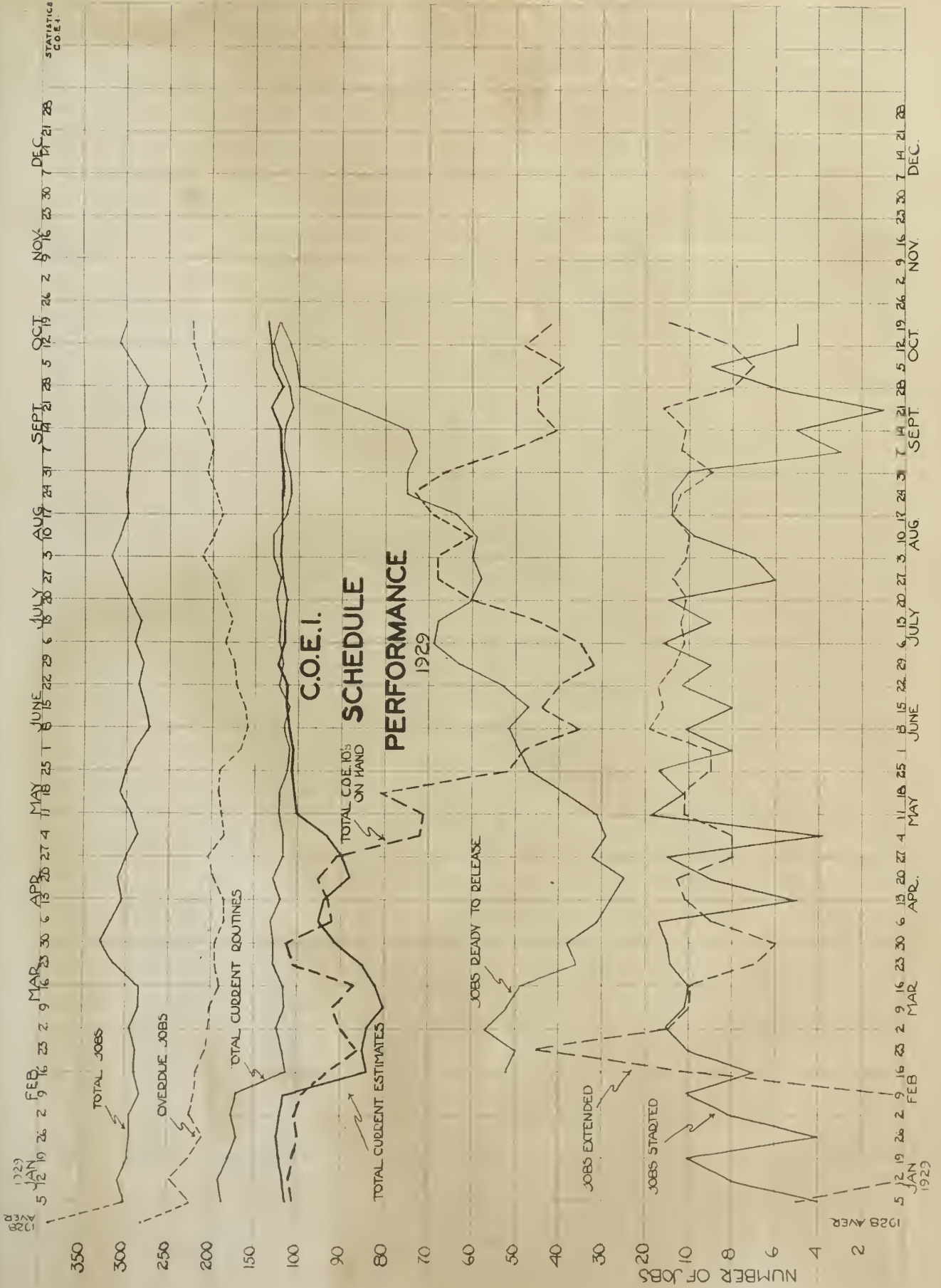


On first glance at this picture it is possible to pick out the periods or months in which cancellations or part cancellations occurred. It should not require much effort to determine the cancellations by measuring optically the deeply shaded and half-tone areas. A study of this sort permits a view of several years performance.

More important, perhaps, than any one of these individual schedule studies, is a picture of the several factors combined in one chart. If this can be accomplished, the various performance curves will appear in such adjacent relation to one another, that any inconsistencies or abnormalities will be readily apparent.

On the next page such a chart has been presented, and although no argument need be made for its value, one of the curves probably requires an introduction. This is the curve on C.O.E. 10 performance. The form number COE-10 referred to, is merely a term commonly used for the completion notice from the job to the office.

The reader will probably recognize the value of this concentrated picture of so many schedule factors. To the executive desirous of a means by which to keep these factors under constant surveillance, this chart is of significant



value. The relative positions, as well as the general tendencies of these curves, are definitely expressive or suggestive of conditions with which the management is naturally concerned. To select only one of the disclosures provided by this chart, we might note the consistent relation of the two curves at the extreme top, viz: Total Jobs and Overdue Jobs. Any tendency of this second curve to approach the curve above, would indicate an increasing condition of overdue jobs - a condition not very complimentary to someone, whether it be the field supervisor or the schedule supervisor, or perhaps, the planner. In like manner, each of these curves tells a story, or at least, contributes to the premise of a conclusion.

Perhaps it would be well, in connection with Scheduling, to consider a study on particular projects. As a means of viewing the general schedule performance as applied to the specific projects, some sort of study should be prepared providing a "birds-eye" view of the various installing intervals throughout the year, or, better still, throughout a period of several years. A better understanding of the proposed study can be had if the reader will glance at the chart on the next page.

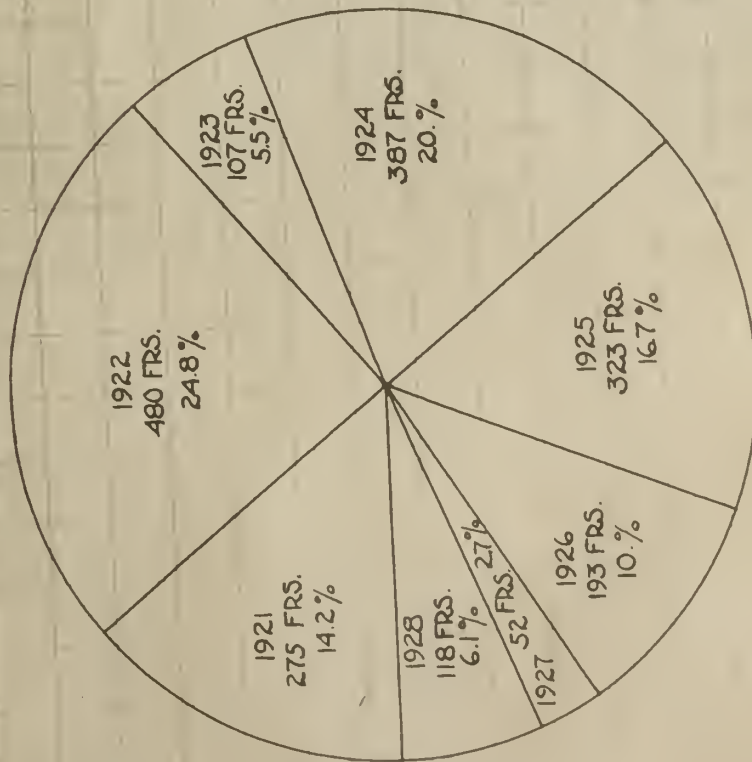
In order to enhance the value of this study, jobs of like nature have been grouped and confined to their respective charts, thereby providing separate views of the various types of installations from a schedule standpoint. The particular chart used to exemplify this study covers the #11 Type Offices, and similar charts are possible on all other types of installation.

It will be noted that the installing interval consumed on each of these projects is designated, not by an even dash of ink, but by a cone-like dash. A two-fold purpose was served in this instance for not only is the installing interval designated, but also, the rate of progress. The use of this type of flag makes it possible to determine the percent of completion at any given month of the total interval, five small squares being the measure of total completion. If a picture is made at the time that some of the projects are only partially completed, and where only the expected rate of progress and prospective completion date are to be had, this estimated portion of the flag can be designated by a dotted outline, as found in the year 1929 in the chart.

Incidentally other very significant facts can be

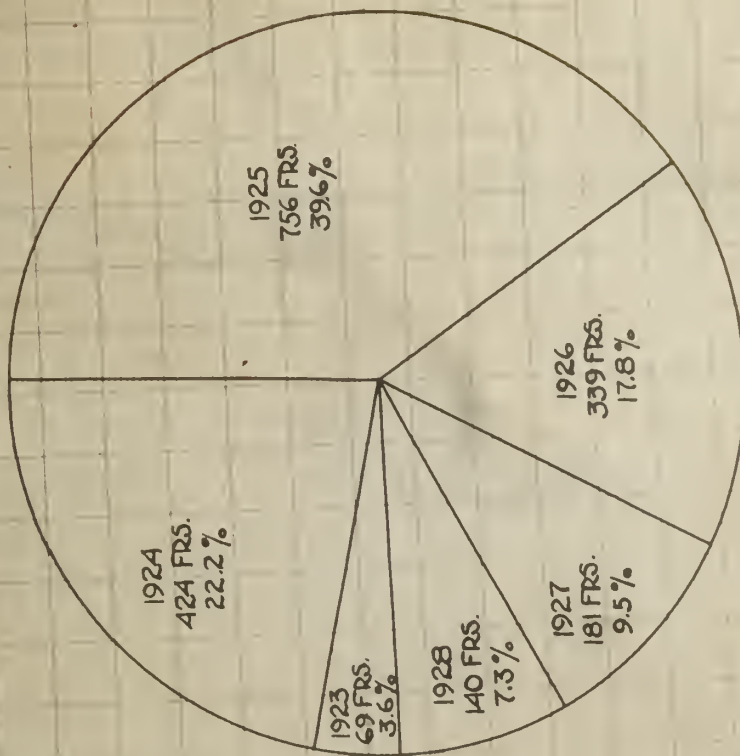
MACHINE SWITCHING TOTAL FRAMES 1921-1928 (INCL)

STARTED



TOTAL FRAMES STARTED
1935

COMPLETED



TOTAL FRAMES COMPLETED
1909

provided along with this schedule of jobs. Some suggestions are to be found in the upper blocks of the chart under consideration. Each of these items should be self-explanatory and their value in connection with a survey of this kind must be conceded.

Before passing from the schedule standpoint, there is another study of real value in providing a comparative yearly picture of performance. A "pie chart" has been constructed to portray the data in this case, as shown on page 127. Here the schedule performance has been studied at both ends of the interval of construction. In one sphere we have the several year's performance in starting, while in the other the rate of completion is shown. In addition to the number of frames started or completed, in each of the years shown, the percentage of each year to the total is provided.

CHAPTER X

Planning and Inspection

It is not because of any close affiliation of Planning and Inspection that we find them both under the one chapter, but only because each is to be considered very briefly, and therefore, the allotment of a full chapter is not warranted for either.

Planning

Although planning as applied in most industrial concerns today is associated very closely with scheduling, this function when mentioned in connection with central office installation carries an entirely different connotation to telephone people familiar with its application. Planning in this instance is very definitely applied to specific jobs, to the exclusion of all routing and posting of papers. The distinction, however fine, may be recognized by the fact, that planning as we are to consider it, is nothing more than complete analyses of specific projects. This analysis or plan of the job begins where work should begin and ends where the work should end.

All proposed projects, whether they amount to Estimates or Routine Orders in size, or whether the proposed

work is construction, removal or maintenance, are either planned, estimated, or waived. The size and importance of the proposed job determines whether it warrants planning, or even estimating. It so happens that 300 hours is considered a justification for planning. If it is necessary to plan, a very minute analysis is made of the requirements, and intervals for operations are provided by the use of established standards or "constants". Some of these operations are allotted as fine an interval as .006 of a minute. It can be seen from this that minute precision is obtained.

Not to consume too much space in the description of planning, we will consider a study made to check on the performance of the planning organization. On the next page will be found a chart to show the planning output for each week. The dividing border of 300 hours separates the jobs requiring a plan from those of inconsequential size and importance. At a glance it can be determined just how many large jobs have been neglected, and, at the same time, how many smaller ones have taken up the time of the planners.

If conditions were ideal, this chart would show all of the jobs below 300 hours as blanks, or "waived", and

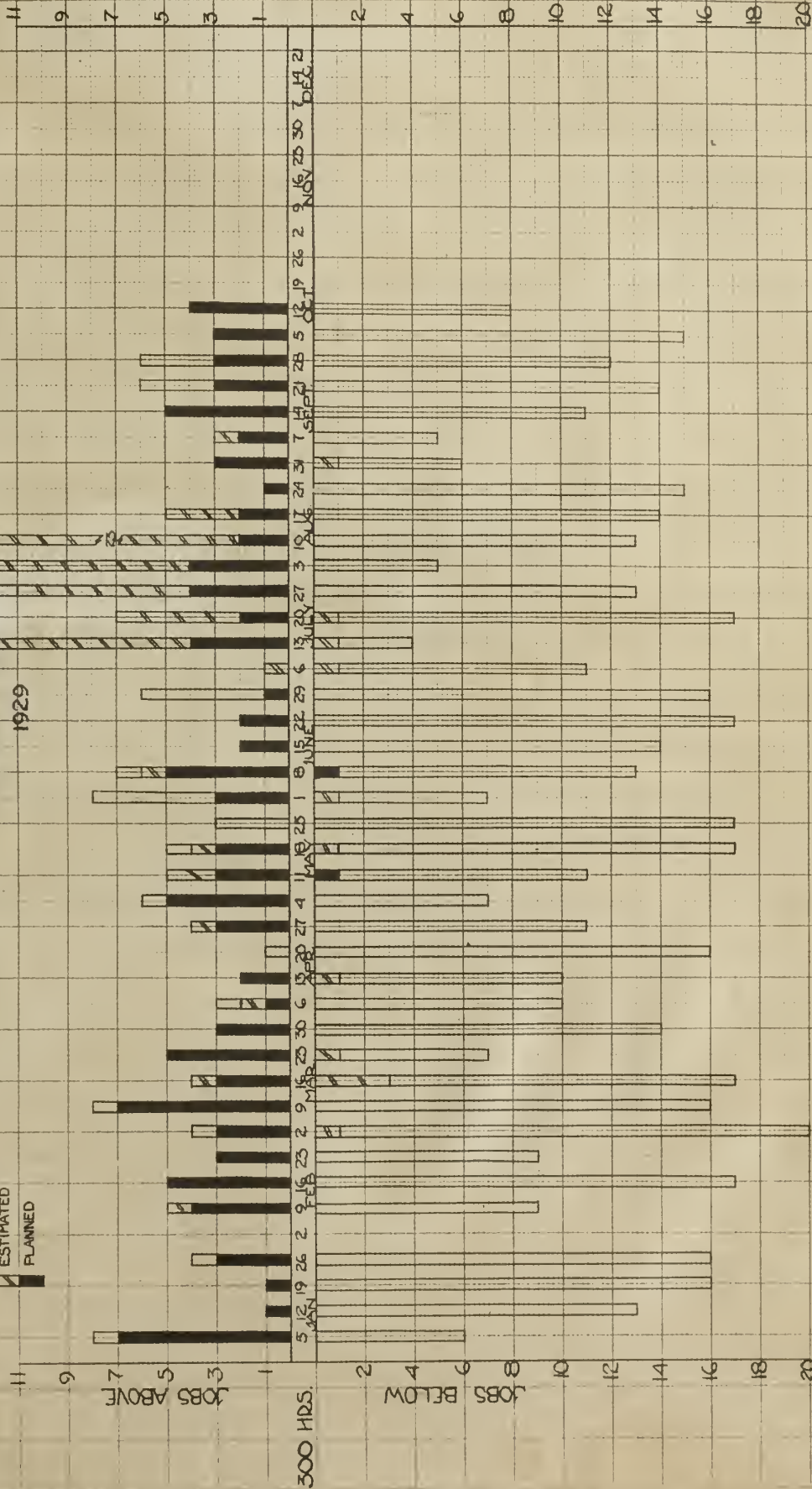
STATISTICS
C.O.E.I.

MANUAL PLANNING

C.O.E.I. DEPT.

1929

WAIVED
ESTIMATED
PLANNED



all of the jobs above, as black, or "planned". As we find the situation here, however, some of the smaller jobs were estimated, or even planned, while some of the larger ones were also merely estimated, or even waived. This would seem to indicate that the planning force is either neglecting to plan all of the large projects, or is finding it difficult to adequately handle the great number of jobs passing through. Whatever the trouble is, the situation is made clear by this chart and the executive following these graphic indications is familiar now with the state of affairs in the planning order of things.

Let us now change our viewpoint in this matter and consider the results being obtained from the field forces on these planned appropriations. The magnitude of some of these projects occasions a somewhat large over-run or under-run of appropriations, and with no justifiable reflection on either the field force or the planning department. Unforeseen conditions and unavoidable obstacles often constitute legitimate reasons for excess expenditures, and while these excesses amount to considerable in dollars, they are only a patch when considered in proportion to the cost of the total project. And so, it might be considered that a good control of planned jobs is obtained in the final analysis.

The table below has been prepared to show the results obtained over several years, and here it will be noted that the average over-run of appropriations is only \$778, while the average under-run is \$1266.

Table G

Under-run and Over-run of Appropriations

	<u>Under-run</u>			<u>Total</u>
	<u>1927</u>	<u>1928</u>	<u>1929</u>	
Total Jobs	86	83	13	182
Total Amount	498613.	384227.	22788.	905628.
Mean (Aver.)	1005.	1040.	1753.	1266.

	<u>Over-run</u>			
Total Jobs	79	83	12	174
Total Amount	147422.	152601.	6965.	306988.
Mean (Aver.)	859.	968.	508.	788.

Inspection

While the inspectors are examining the work of the installers, they are not immune from supervision themselves. Studies on their performance are of value, of course, but such studies are made primarily, not to check

up on the inspectors, but rather to show the conditions being disclosed by the inspections. Serving a two-fold purpose, inspection studies incidentally reveal the amount of work being done by the inspection force.

Inspections are naturally reported into the office, weekly, at least, providing data for a running record should statistical information be desirable. Little effort should be required, consequently, in recording and summarizing. As simple as the following table might be to prepare, it provides, nevertheless, significant facts regarding the quality of work, as well as, the activities of the inspection forces.

Table H

Weekly Inspection Facts

	<u>January</u>					<u>February</u>			
	5	12	17	24	31	7	14	21	28
Inspected	18	21	9	29	42	12	16	14	19
Accepted	10	12	9	21	30	10	8	9	18
Rejected	5	2	0	5	2	2	6	3	0
Waived	3	7	0	3	10	0	2	2	1
Total Jobs Submitted	21	28	9	32	52	12	18	16	20

Assuming that inspection facts like those above had been carried throughout the entire year, a total could be obtained to show the year's performance. Similar tables could

be prepared for each division and the quality of installation work could then be compared, as between divisions. However, as much as we have presented above will serve to demonstrate the simplicity with which these data might be effectively arranged. The figures found in the above table provide the supporting data for the chart on page 136, wherein each of the inspection factors is shown in relation to the total completed projects on hand, and likewise, in relation to one another.

Little more could be expected by the executive in matters of inspection unless we were to go into minute detail and attempt to show reasons for rejection. To do this would require considerable research, and would probably prove to be a needless investment of time in view of the insignificant facts obtained. As we have pictured the situation here, several ratios are provided to afford an adequate portrayal of facts uncovering the degree of quality in installation work, as well as the extent of inspection activities from week to week.

Like many of the other studies with which we have dealt, inspection performance from year to year will, no doubt, hold interest for the supervisor, and consequently,

STATISTICAL
C.O.E.I.

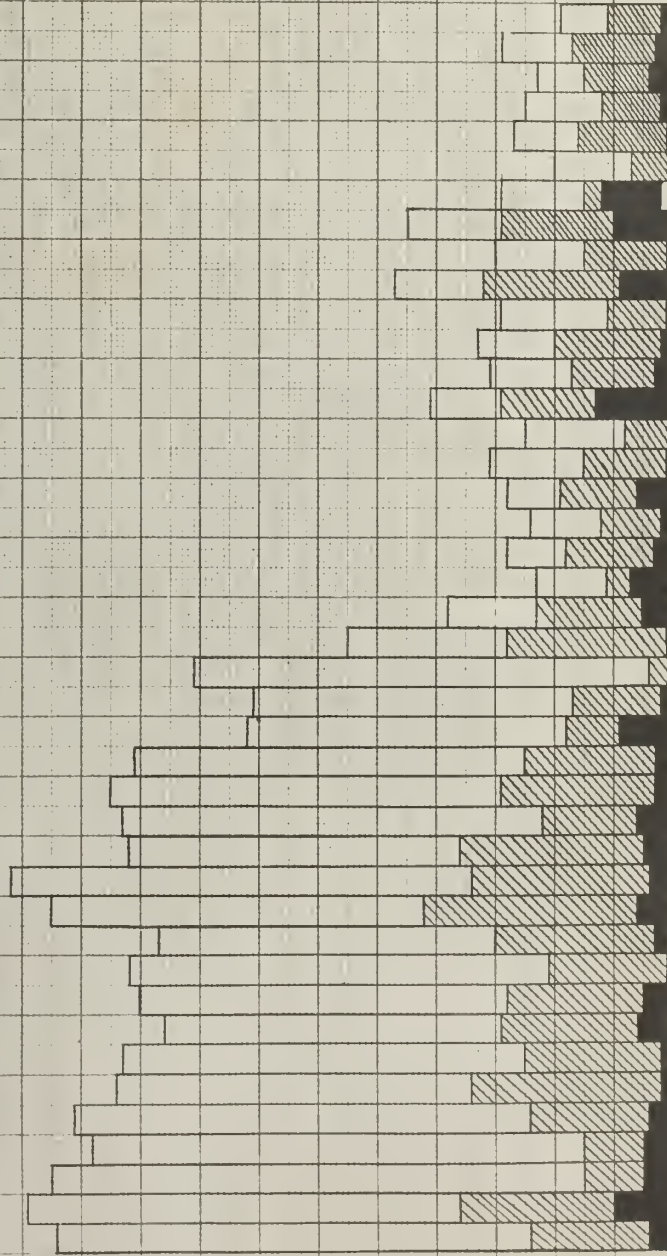
INSPECTION C.O.E.I. DEPT. 1929

C.O.E.I.'s ON HAND
JOBS - INSPECTION WAIVED
JOBS - INSP. & PASSED
JOBS - REJECTED

JOBS

110
100
90
80
70
60
50
40
30
20
10
0

5 12 19 26 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 5 12 19 26 2 9 16 23 30 7 14 21 28
JAN FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.



the bar chart on the next page is constructed to afford this yearly comparison. This chart, coupled with the previous one, covers the chief factors of interest to the executive on the inspection subject.

Many significant facts are manifest in this three-year comparative view, as will be apparent after a few minutes' analysis. In the first section it will be noted that few jobs are being completed from year to year. In the second part it will be observed, that while the inspectors have passed upon all jobs submitted in 1926 and 1927, they have not accounted for all jobs submitted in 1928. Incidentally, in 1928 fewer jobs were waived. The last portion of this chart discloses the fact that the percentage of rejections is increasing from year to year. Whether this is significant of poorer quality in installation, or stricter exactions by the inspection forces, we cannot say. This point could be checked up very readily, however, if the reason is desired.

Presented By: PCD

RECORD

COMMITTEE

ACCEPTANCE

C.O.E.I. DEPT.
N.E.T. & T. CO.
-1928-

SUBMITTED

VISITED & WAIVED

AVERAGE PERCENT REJECTED

3000

3000

1926 1927 1928

1926 1927 1928

1926 1927 1928

WAIVED

VISITED

2000

2000

NUMBER OF JOBS

NUMBER OF JOBS

1000

1000

PERCENTAGES

2

3

4

5

6

7

8

CHAPTER XI

Miscellaneous Studies

Under this chapter an attempt will be made to present certain studies which are considered special although they could very well be classified as personnel matters. It is often necessary to produce special studies of a miscellaneous variety because of momentary questions or discussions. Oftentimes concerns foster prize contests and the like, wherein certain quotas are sought, such as; first-aid training, stock subscriptions, training schools, and the diminution of accidents and sickness. Inasmuch as such contests or campaigns exist, results are sought.

Stock Subscription

Let us consider a few of these activities, and, beginning with stock subscriptions we will consider the data presented on the next page in Table I.

Table I

Stock Subscriptions

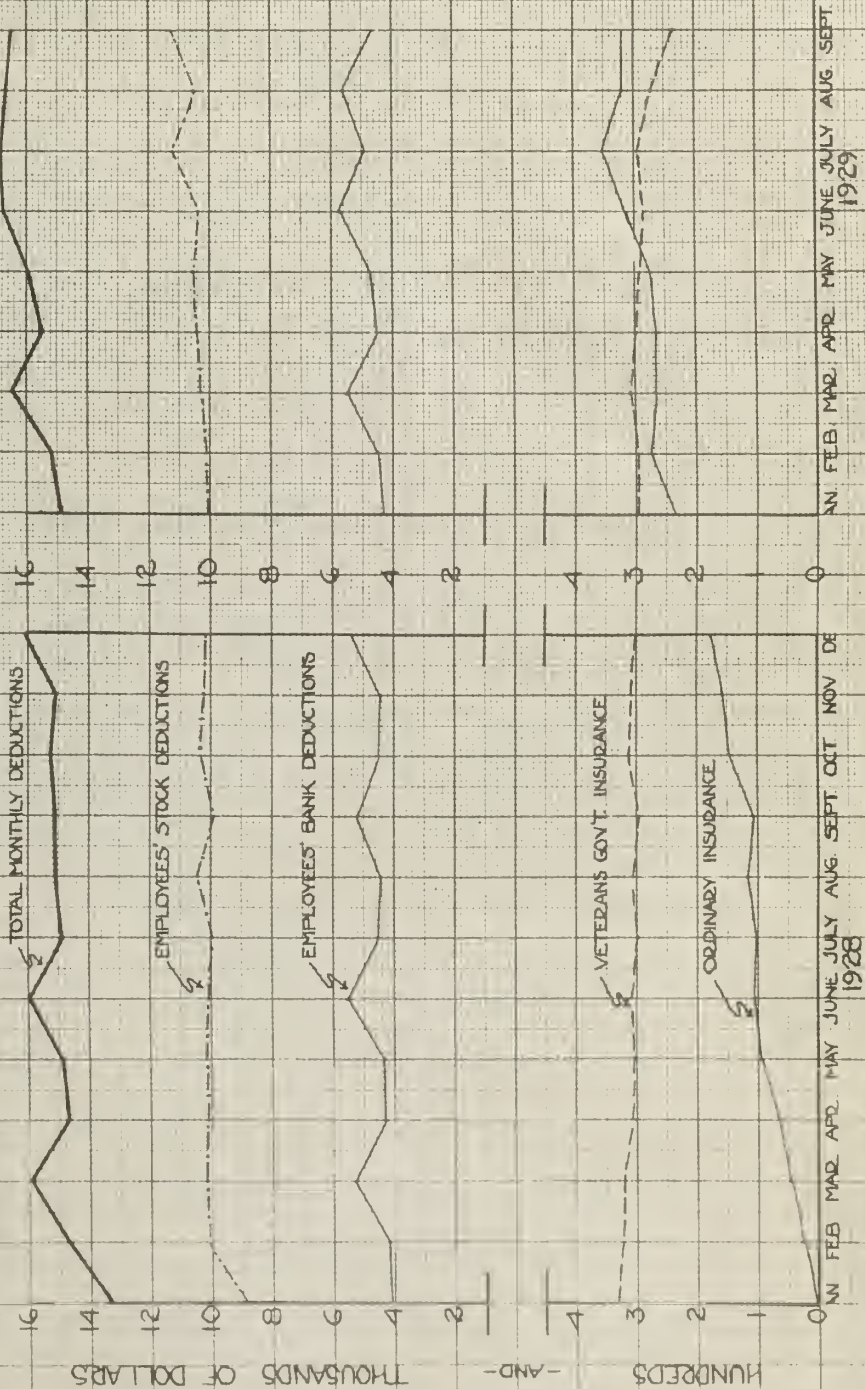
March 1929

Department	A	B	C	D	E
	No. of Emp. Elig.	No. of Shares Elig.	No. of Shares Taken	% of Shares Elig. being Sub. for	No. of Emp. Subsc.
Planning & Service	23	235	153	65	22
Tool Room	9	68	54	79	9
Accounting & Clerical	30	171	121	70	30
Test & Inspection	10	109	66	60	10
Supv. & Supv. Foremen	25	277	217	78	24
Field Force	462	3751	2637	70	441
Monthly	10	161	151	93	10
Totals	569	4772	3399	71	546

In the above table we find the response each group of employees has made to the extended privilege of subscribing to stock. The proportion of eligible employees can easily be determined from these figures, and, consequently, a complete story of this angle of the subject is provided.

Let us view the trend of stock payments by employees over several months, and incidentally observe several other thrift habits to determine the trend of such things. The stock, insurance, and savings curves will be found in the chart on page 141.

PAYROLL DEDUCTIONS C.O.E.I. DEPT.



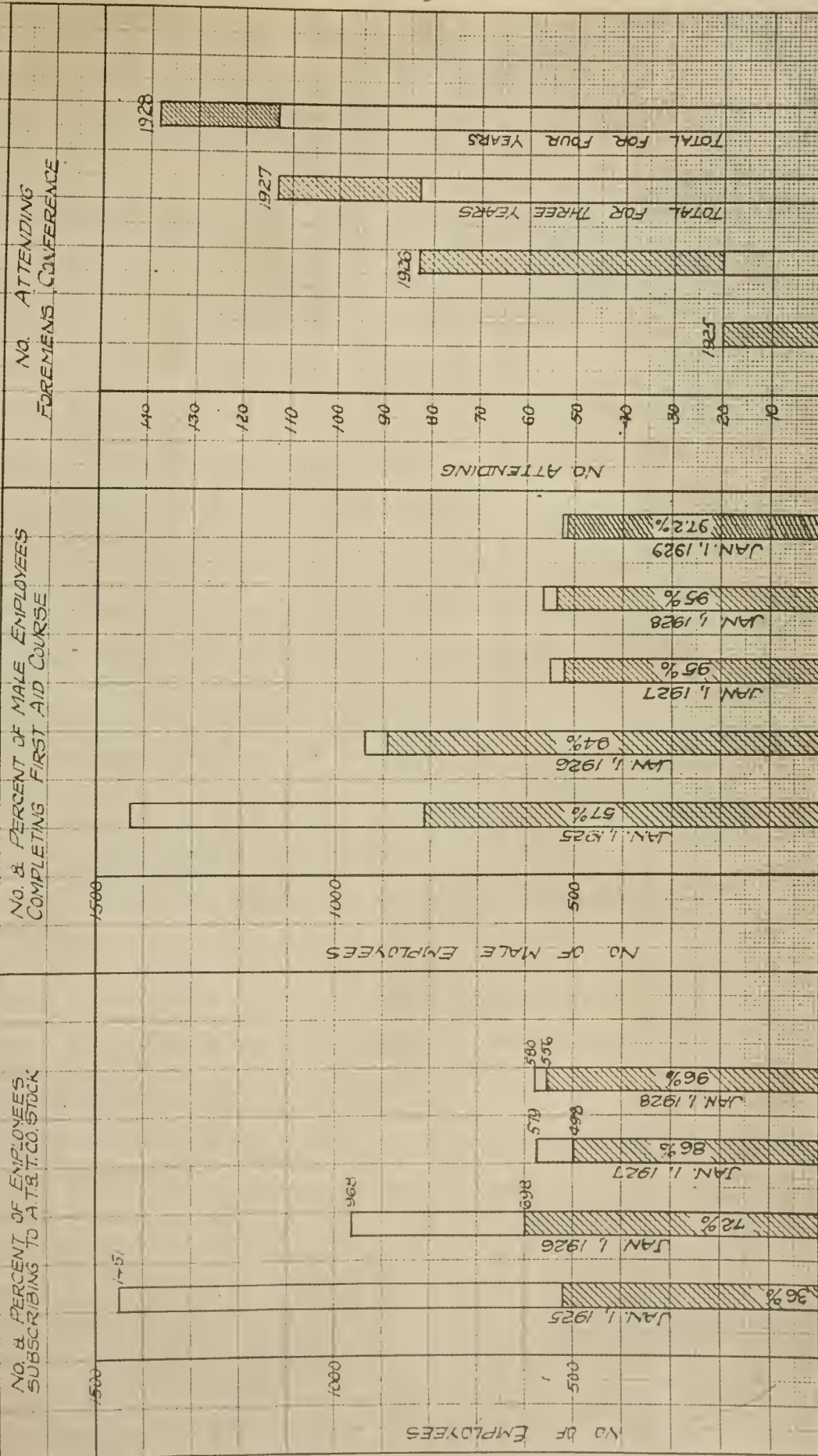
The trends of these curves are indications to the management of the attitude of the employees collectively, regarding these thrift policies.

It should be of further interest to the management to know what percent of the total employees is subscribing, and what increase, in percent, if any, is taking place from year to year. The bar chart on page 143 provides a four-year comparative view of stock subscriptions, giving the percentage, as well as the absolute number of employees subscribing. This study will be found in the first section of the chart. The other two sections pertain to studies with which we are to deal presently. It might be said here, however, that all three studies found in this chart indicate a clearly favorable tendency from year to year.

Training Activities

The middle section of this chart has been given over to the study of first-aid training activities. It will be generally conceded that the promotion of first-aid training is a commendable and worthy policy. Results in this activity are likewise sought by the management, and favorable results are in evidence here as can be readily seen by glancing at the comparative yearly status. The fact that these bars are

STOCK PURCHASE ~ FIRST AID ~ FOREMENS CONFERENCE



diminishing from year to year, merely indicates that the total force has been reduced to that extent. The proportion of employees not having completed first-aid training is found in the unshaded portions of the bars, and this untrained portion will be found to have reached practically the point of extinction.

The third study found on this same chart provides a cumulative view of the number of foremen attending school from year to year. This study is really of small significance and serves merely to fill the space in the chart, although it has its story to tell nevertheless. In the event that the question is raised, or an interest is manifested in foremen's training activities, such a study would serve to provide a good account of things.

Accidents and Sickness

The question of accidents and sickness, especially such cases as are serious enough to occasion lost-time, has been for some time one of the necessary evils sought to be eliminated, or at least, cut down to a minimum. Perhaps the attitudes of the various managements fostering accident prevention policies is not entirely altruistic - some, no doubt, are. Whether or not they are considering the employee's

welfare, the fact remains that it pays in the long run. Lost-time accidents or illnesses cost the firm real money for which there is no return. This being the case, it pays to promote preventative measures, regardless of the initial cost.

Let us consider a survey of accidents to be presented in tabular form. In the table, let us show a complete statistical summary of facts showing frequencies, causes, and numbers of accidents resulting in lost time. Table J on the next page provides these facts, as well as ratios per one hundred employees.

While the data presented in this table is quite complete in its disclosures within the department, it does not serve to show the comparative standing of the department as against other departments. It is very likely that an interdepartmental view of these occurrences should be sought. Without some means of comparison it would doubtless be difficult to determine whether or not the showing is good.

An all-embracing study of accidents has been made to provide a comparison of the conditions in the several divisions of the Plant Department of which our department is one. The combination table and chart found on page 147 brings

Table J

Summary of Accidents - May 1929

CAUSES:	<u>MANUAL</u>	<u>MACH. SWITCH.</u>
Objects striking or being struck	15	12
Slipping, Falling, Tripping, Stumbling	0	1
Lifting, Pulling, Carrying	4	0
Tools (the use of)	8	3
Splinters	1	0
	<u>28</u>	<u>16</u>

Minor Accidents	41
Lost-Time Accidents	<u>3</u>
Total	<u>44</u>

<u>MECHANICAL JOBS</u>	<u>MANLOAD</u>	<u>NO. OF LOST-TIME ACCIDENTS</u>	<u>RATES PER 100 MALE EMPLOYEES</u>
Geneva	80	0	0
Columbia-Talbot	29	0	0
Highlands	92	0	0
Aspinwall	58	0	0
Kenmore	77	0	0
Milton	10	0	0
Liberty	82	1	1.22
	<u>428</u>	<u>1</u>	<u>.233</u>

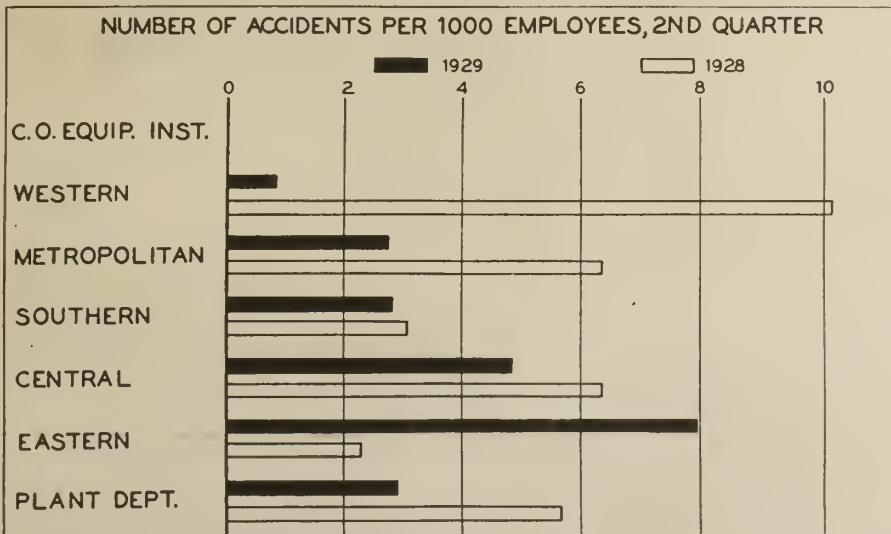
MANUAL JOBS

Central District	129	1	.774
North District	65	0	0
North West District	83	0	0
West District	39	0	0
South District	47	0	0
Central Division	125	1	.775
	<u>488</u>	<u>2</u>	<u>.409</u>

TELEPHONE TOPICS

MAJOR ACCIDENTS PER 1000 MALE PLANT EMPLOYEES
QUARTERLY COMPARISON - 1929 AND 1928
NEW ENGLAND TEL. & TEL. CO., PLANT DEPARTMENT

	1929								1928							
	STANDING				RATIO PER 1000 MALE EMPLOYEES				STANDING				RATIO PER 1000 MALE EMPLOYEES			
	1ST Q.R.	2ND Q.R.	3RD Q.R.	4TH Q.R.	1ST Q.R.	2ND Q.R.	3RD Q.R.	4TH Q.R.	1ST Q.R.	2ND Q.R.	3RD Q.R.	4TH Q.R.	1ST Q.R.	2ND Q.R.	3RD Q.R.	4TH Q.R.
C. O. EQUIPT. INST.	1	1			.000	.000			1	1			1.890	.000		
EASTERN	2	6			1.957	7.952			4	2			4.739	22.83		
METROPOLITAN	3	3			3.215	2.749			3	4			4.566	6.346		
SOUTHERN	4	4			5.769	2.833			2	3			2.092	3.096		
WESTERN	5	2			6.329	.864			6	6			8.451	10.176		
CENTRAL	6	5			7.064	4.883			5	5			7.559	6.397		
PLANT DEPT.	-	-			4.416	2.915			-	-			5.092	5.683		



TELEPHONE TOPICS

48-59

LOST TIME ACCIDENTS, 1924-1929 PLANT DEPARTMENT

		1 MO.	2 MOS.	3 MOS.	4 MOS.	5 MOS.	6 MOS.	7 MOS.	8 MOS.	9 MOS.	10 MOS.	11 MOS.	12 MOS.
METRO.	1924	*13	23	24	36	43	48	60	63	69	81	93	*103
	1925	3	8	15	24	32	32	33	39	46	56	65	68
	1926	6	7	8	14	17	22	24	28	30	30	37	40
	1927	3	5	12	19	23	26	27	36	42	51	60	66
	1928	3	6	*10	15	20	24	*27	37	44	51	55	*59
	1929	4	5	7	10	11	13	14					
EAST.	1924	1	2	3	4	4	10	12	17	18	21	21	24
	1925	2	4	8	10	11	11	11	11	11	11	11	12
	1926	0	1	1	2	2	2	4	7	8	8	8	8
	1927	2	2	6	7	10	10	10	11	11	11	13	13
	1928	0	2	2	2	2	3	3	4	5	6	7	7
	1929	0	1	1	2	3	5	5					
CENT.	1924	5	12	16	20	28	34	44	55	60	69	79	*91
	1925	10	16	20	22	24	*26	27	27	28	29	30	*30
	1926	1	2	4	5	5	6	8	9	12	13	13	15
	1927	4	5	9	9	11	11	*14	14	15	20	22	*23
	1928	2	4	7	10	12	13	13	13	13	15	16	22
	1929	1	6	7	7	9	12	15					
SOUTH.	1924	11	21	*43	54	65	73	80	89	97	107	120	*126
	1925	3	7	9	16	17	18	20	23	26	28	29	32
	1926	3	5	8	9	10	13	13	13	13	15	15	19
	1927	*3	3	7	11	12	13	14	14	14	18	18	*19
	1928	2	2	2	2	3	5	6	8	8	9	10	13
	1929	2	4	6	7	8	9	10					
WEST.	1924	4	12	18	27	32	44	52	59	70	75	79	82
	1925	2	5	11	13	19	24	26	30	30	31	31	31
	1926	3	3	3	3	5	8	9	15	19	22	25	25
	1927	5	7	13	18	21	*25	31	34	36	39	40	*43
	1928	4	5	9	13	17	20	24	31	31	33	33	35
	1929	**3	7	7	8	8	10	11					
C.O.E.I	1924	0	4	6	7	9	11	16	16	16	19	22	28
	1925	1	2	11	14	15	18	18	19	19	19	19	19
	1926	0	0	0	1	2	2	2	2	2	2	2	3
	1927	0	0	0	1	1	1	2	3	4	4	4	4
	1928	0	1	1	1	1	1	1	1	1	1	1	2
	1929	0	0	0	0	0	0	0					
TOTALS	1924	*34	74	*110	148	181	220	264	299	330	372	414	*454
	1925	21	42	74	99	118	*129	135	149	160	174	185	*192
	1926	13	18	24	34	41	53	60	74	84	90	100	110
	1927	*17	22	47	65	78	*86	*98	112	122	143	157	*168
	1928	11	20	*31	43	55	66	*74	94	102	115	122	*138
	1929	**10	23	28	34	39	49	55					

A star beside any figure on this chart indicates that during that period there was a fatal accident. Two stars indicate two fatal accidents.

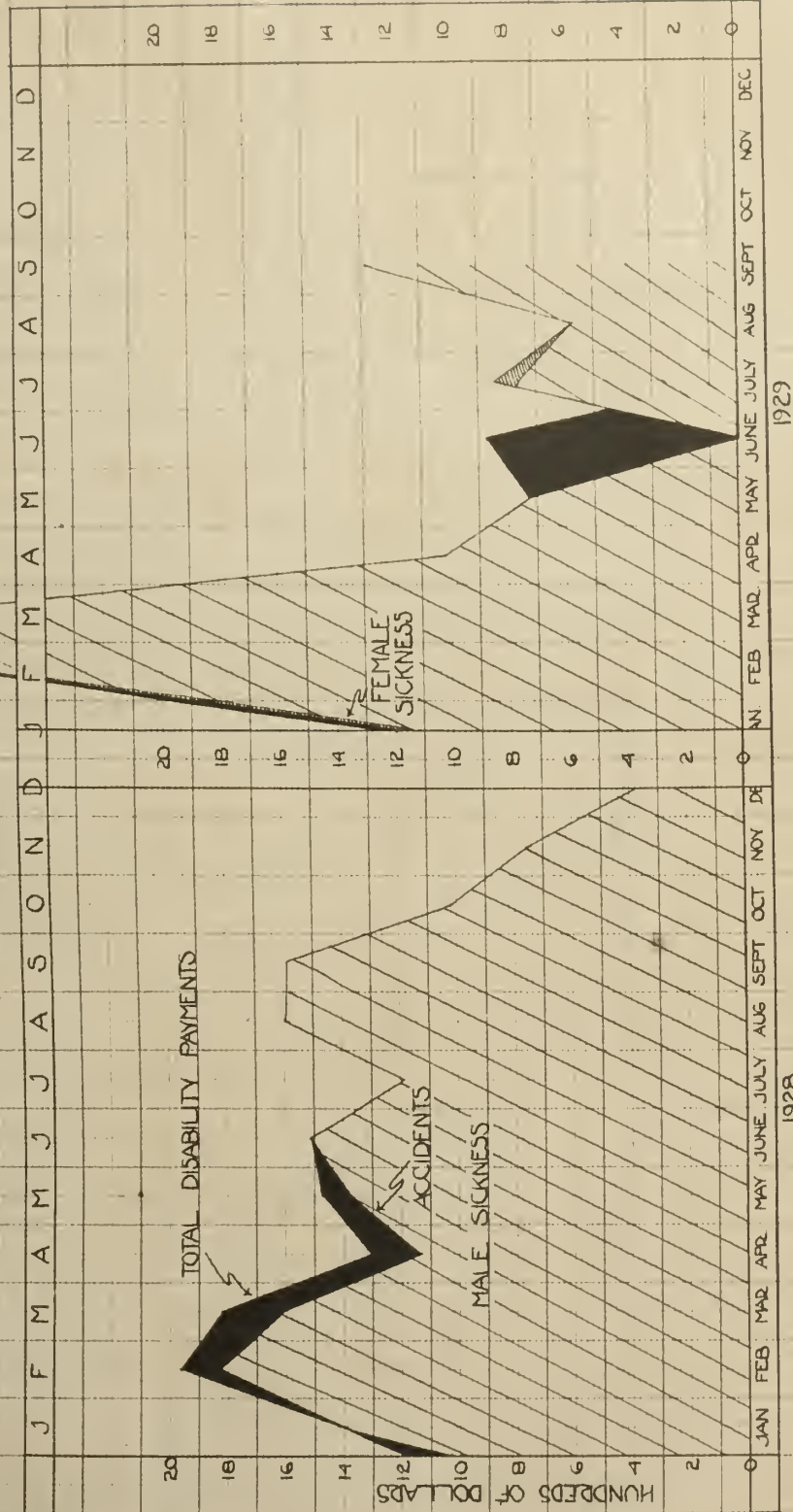
out very clearly the relative standing of each division, and at the same time provides a comparison of two quarters of the present year with the corresponding quarters of the previous year. Incidentally it will be apparent that the Central Office Installation Department holds first place in the league for accident prevention.

In this connection we might consider similar data over several years and thereby determine the increase or decrease in accidents. The table on page 148 gives a cumulative record of lost-time accidents for six consecutive years, and affords a comparison of the occurrences of the several divisions. This table as well as the one immediately preceding it, was extracted from "Telephone Topics", the monthly organ of the New England Telephone Company.

To revert to our departmental viewpoint, there is one other study that should be considered and illustrated before closing this chapter. This is the analysis of disability benefits paid. A portrayal of the curve on this item affords a good view of the trend of sickness or accident. The graphical picture will be found on the next page wherein the proportions of accident and sickness are brought out clearly.

It must be acknowledged that the amount found at any

DISABILITY BENEFITS PAID C.O.E.I. DEPT.



given month represents dollars spent, and this could involve several cases, and yet it could just as likely be applied on only one case. In view of this, the reader of the chart cannot assume that any number of disability cases prevail, but only that disability as a whole amounts in dollars to the figure denoted by the curve.

Any number of miscellaneous studies could be produced on the various activities and interests of the organization, but to illustrate any more here would probably be superfluous effort in presenting the argument for the value of such studies. Although some subjects are more difficult to portray graphically than others, there are very few, if any, that cannot be presented in graphical form.

Chapter XII

Conclusion

The advent of statistics as a science has brought with it a great profusion of complicated terms and formulas. Before the war the chief demands along such lines were for ordinary numerical description of facts, stated in simple totals and averages usually. With the new need for scientific procedure, however, occasioned by the ever-increasing complexities of business, coupled with the advances in statistical education, these earlier elementary methods and demands have gradually become inadequate.

The statistician of today dealing with a distribution of observations uses, in place of the common average and total, the mean, the median, and the mode to express the center of a group. The use of such methods has brought into play a whole vocabulary of strange terms, a multiplication of mathematical symbols probably entirely incomprehensible to the uninitiated, but, on the other hand, a source of deep satisfaction to the trained statistician.

Such technical terms and formulas have been intentionally avoided in the studies presented with this thesis, in order not to

confuse the reader should he be unprepared to interpret them. Mention is made of these more advanced professional methods merely to acknowledge their existence and to demonstrate that the results ordinarily required by the business executive can be obtained by the use of the commonly known terms and symbols. In fact, many executives would find it impossible or, at least, very difficult to interpret charts of this highly technical nomenclature.

It has not been the intention, furthermore, to present all types of charts, and neither have all varieties of types been attempted. Only enough have been constructed to portray a fair selection, serving to demonstrate the value of such pictures to the management in controlling methods and policies.

Perhaps it is well, before closing, to again remind the reader that all charts and tables used in connection with this thesis have been prepared for purposes of demonstration, and are not to be considered authentic as far as the primary information is concerned. To effectively demonstrate the chart's value in disclosing delinquent conditions, these imaginary conditions had to be created, and consequently, legitimate data was valueless in many of the studies.

Indisputable Value of Research and Statistics

All firms of any consequence keep records of all transactions and operations. In fact, records are essential to the intelligent progression of any industry. Considerable expense is incurred wherever records of any large extent are maintained, and therefore, the classification of accounts should be made with the purpose in mind of future statistical use. Records in their usual form provide no means for providing the perspective needed in the control of general things. It is not expected that the executive be able to visualize any condition from a mass of figures, and therefore, records in available statistical form are advocated.

Statistical analyses of the performances in an organization are aids in arresting any unsatisfactory flow of events, and by their emphasis of vital and key points, they afford ample indication of the true conditions prevalent. Graphic charts as a means of bringing out the significant factors of the study are proving their worth every day. A well designed graph, which presents the essential facts in relief, enables the reader to focus his attention just where it is needed.

It is a subconscious habit of man to judge and

estimate sizes and proportions by the eye. Consequently, the best way to convey an impression of quantity or trend is by means of the nearest approximation to an eye view. Here is where the chart proves its worth. To the human memory, pictures and forms provide a more vivid and lasting effect than do figures. The chart, therefore, creates impressions manifestly impossible in the realm of figures. Furthermore, it stimulates analytical thinking and suggests questions that never would have occurred otherwise. It prompts further research to explain certain disclosures - facts, sometimes alarming, sometimes gratifying. Resources of information are marshalled into concise and effective form and inconsequential details are not permitted to detract from the significance of the vital facts.

Precedents, often proving detrimental later, are established during a period of snap judgments and guesses, and these are not uncovered until proof of their fallacious character is brought out by analysis. By reason of the element of change to which they are so susceptible, precedents are inadvisable even after careful and systematic analyses. To disclose the existence of such set policies, therefore, is to open wider the avenue to more rapid progress.

Not only are the failings and mistakes of the past brought to light, but warnings of possible future "pitfalls" are flashed by graphical portrayal of trends and occurrences. It will be remembered that several of the charts found in previous chapters provided a month-to-month or week-to-week story of performance, affording an opportunity to arrest any unfavorable divergence from normal. These, like many of the over-all pictures, brought together otherwise estranged facts, making it possible for the executive to "keep his finger on the pulse" of operations.

Dealing in truth and realities as it does, the statistical chart must recognize the inflations and depths of things. It is concrete and informal, extracting true indications from a mass of data, the ingredients of which have little usefulness in their individual rights, but contributing to the disclosures afforded by their combination - often facts of manifold significance.

Prospective Future

If the recent increase in the use of statistics and the statistical method is any criterion, we might well expect considerably greater development of methods and an inevitable growth of instances of use, in the future.

The last twenty-five years have set so tremendous a stride in this new science, that the immediate future with its constantly increasing complexities must of necessity resort to this fact-finding method of control to a correspondingly greater extent.

Being related to, and experiencing its derivation from accounting and mathematics, this new science inherits selected and valuable traits of these parent processes. Along with this stamp of derivativeness, comes certain established and tested tools providing an early advantage in its progression as a distinct science. Unleashed from all confines peculiar to sciences, and enjoying such unlimited and fertile fields for application, statistical analysis should promise a much more rapid development and expansion than did any of the existing arts and sciences. While Physics might encroach upon Chemistry, and Economics might overlap Logic, Statistics may cover them all and still remain within the scope of its legitimate practice.

Of the provisions attributed to the statistical method, the one which seems to distinguish and compliment this new method most, is the faculty of rearranging dormant facts into new and significant forms, combinations, and relations. As this possibility began to assert itself

and successful attempts were made in cutting loose from the lower forms of colorless data, revelations resulted and hence, the impetus for increased facilities for statistical work.

As the value of statistics came to be realized in the commercial and financial world, the need for added facilities became apparent. Elaborate systems resulted in a great many offices, even to the extent of installing large rental sorting and tabulating machines, which are run by electricity. Although all concerns do not install mechanical devices, most of them establish an accounting system with records so arranged as to be available in suitable form for anticipated statistical research.

Statistics, as we encounter them commonly used today, are prevalent in large-scale activities, and their value is undisputed. Like all innovations, this science is first utilized in the large and heretofore unwieldy problems. Results in such applications are apparently gratifying and the method is flourishing universally. However, the value of statistical analyses is not fully recognized in smaller subsidiary departments of industry. This scientific method of research has long since thrown off its allegiance to purely political, civic, and religious

circles, and has extended its services, not only to business as a whole, but to the innermost recesses of the business functions.

To ignore the need for scientific procedure in production within the organization, is to invite the inevitable reflection of slipshod methods in the product. Only through foresight and design can anything be done efficiently and economically. Everything done under the direction of the intellect is as economical as the degree of intelligence will permit. This degree of intelligence should naturally be augmented by the use of any scientific means available. The failure to use available tools in attaining this maximum economy is due to ignorance or carelessness. Consequently, the essential knowledge of prevailing conditions is wanting.

Because production is going smoothly, it should not be assumed that it is efficient. Perhaps thousands of dollars are being spent needlessly, and with the disclosure of certain faulty conditions, this might be saved. Certain things could be reaching abnormal and disastrous proportions, and unless some scientific method of control is employed, serious trouble might accrue.

Our attitude throughout this entire thesis has been that of the executive, and it has not been presumed that he has had any scientific statistical training. Consequently, everything has been discussed and demonstrated in comprehensive and ordinary commercial language, with a decided effort to avoid all technical methods of statistical computations. It has been the intention to show the value of such analyses, as have been made here, to supervisors having no statistical or higher mathematical training.

Many commendable books have been published covering other more scientific and technical phases of this subject, but many of these would seem to discourage the use of statistical methods by some, by reason of their intricate and technical nature. On the other hand, this thesis attempts to demonstrate the possibilities of such methods of control in all offices. The very simplicity manifest here suggests a field somewhat unexplored, and consequently, little reference can be made to other works of exactly similar content. It is hoped, therefore, that the reader will realize that very little of the material contained herein was obtained from other writers, and that practically all of it was procured by actual laboratory research.

The bibliography to follow is not as extensive as

the writer would like to have it, but the few other books found, pertaining to this subject, were not as nearly associated with our particular theme as the ones given here are.

Evidence of the value of statistics in production and administration, is constantly increasing and indicates the possibilities which their further development will realize. There can be no doubt, therefore, that our future executives are bound to encourage and cultivate this field with increasing intensiveness in the future.

The End.

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